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July 24, 2019

Ms. Sarah Rolfes
Remedial Project Manager
United States Environmental Protection Agency
77 Jackson Blvd.
Chicago, IL 60604

RE: Response to Comments and Transmittal of Remedial Investigation Report, Revision 2
North Branch of the Chicago River Willow Street Station, Division Street Station and North Station Operable Unit 2, North Branch Site
Chicago, Illinois
The Peoples Gas Light and Coke Company
CERCLA Docket No. V-W-08-C-917
CERCLIS ID – ILD982074759 (Willow Street Station)
CERCLIS ID – ILD982074783 (Division Street Station)
CERCLIS ID – ILD982074775 (North Station)

Dear Ms. Rolfes:

This letter provides responses to the United States Environmental Protection Agency's (USEPA's) comments issued on June 24, 2019, on the Remedial Investigation (RI) Report, Revision 1, for the Willow Street Station, Division Street Station and North Station Adjacent River Areas (ARAs, or Operable Units [OU] 2) of The Peoples Gas Light and Coke Company (PGL) North Branch Site.

For ease of review, USEPA comments are presented below in italics, followed by PGL's responses. An RI Report, Revision 2, revised to address the USEPA comments issued on June 24, 2019, is also enclosed.

Agency Comment 1: *Figure 7 shows the following ambient sampling locations as collected within the Willow Street OU2 boundary: ACR-1 (boring), ACR-1 (surface), SWA-1DVS/SWA1WHS, and SCR-01. These samples were taken upstream of the Willow Street upland portion, but within the boundary noted as OU2. Please review and provide additional information.*

PGL Response: The ambient sample investigation was completed in 2011 (Exponent, 2012) in an area upstream of the North Branch Site adjacent river areas. Willow Street Station sediment samples were collected in 2012 in a sample grid approach as described in the Willow Street Station Site-Specific Work Plan (SSWP) Revision 2 (NRT, 2011). Following a review of the Willow Street Station investigation boundary as depicted on the RI Report Figure 3A and other RI Report figures, the upstream boundary has been modified to more closely match the boundary drawn on figure *Goose Island Site* in Appendix B of the October 31, 2008 Administrative Settlement Agreement and Order on Consent for Remedial Investigation and Feasibility Studies (Consent Order) and described in Section 1.6 of the RI Report, Revision 1 (OBG, 2019). In the Consent Order, the upstream boundary of the Willow Street Station OU 2 is approximately 1,150 feet upstream and north of the North Avenue bridge. In the RI Report, Revision 1, the Willow Street Station OU 2 bathymetric survey area (RI Report Revision 2 Appendix C-2), which extends upstream of the OU 2 boundary, was incorrectly used to bound the upstream investigation area.

Following the update of the Willow Street Station OU 2 investigation boundary, samples collected as part of the 2011 ambient study no longer fall within the Willow Street Station OU 2 investigation area. All affected figures have been updated with the modified OU 2 boundary: Figures 1, 2, 3A, 4A, 5, 6A, 7, 8A, 9A, 10A, 10B, 10C, 13A, 14A, 15A, 15B, 18A, 19A, 19B, 20A, and 20B.

Agency Comment 2: *A review of Figures 8A and 15A indicates that there are no samples along the ~250 foot section in the Willow Street OU2 boundary area north of samples PCA-1WHS and PCA- 2WHS, designated as WHS_Upstream in Figure 15A. Please review and provide additional information or clarify the location of samples noted in Comment 1.*

PGL Response: As discussed in the response to Agency Comment 1, following a review, the Willow Street Station OU 2 boundary has been modified to more closely match the boundary drawn on figure *Goose Island Site* in Appendix B of the October 31, 2008 Consent Order and described in Section 1.6 of the RI Report, Revision 1. All affected figures have been updated in the revised RI Report. In addition, sediment sampling locations PCA-1WHS and PCA-2WHS correspond to the farthest upstream sediment sampling locations proposed in the Willow Street SSWP Revision 2 (NRT, 2011).

Agency Comment 3: *Appendix I – Baseline Risk Assessment*

Agency Comment 3a: *The BLRA discusses the current use of the river and adjacent lands in selecting potentially complete exposure scenarios to evaluate. The BLRA assumes that uses of the river and the adjacent land will remain the same (or largely similar) in the future. Please revise the BLRA to indicate this assumption in land use in and along the river (for example, the river will continue to be used for recreational purposes).*

PGL Response: As requested, the baseline risk assessment (BLRA) has been revised to clearly discuss the assumption about future land use being like current land use, which includes the continued use of the North Branch of the Chicago River for recreational purposes. Recreational use of the North Branch Chicago River has become a valued ecosystem service. This additional discussion has been added to the first paragraph of Section 2 of the BLRA (Revision 2).

Agency Comment 3b: *The BLRA acknowledges the fact that calculation of surface water-related risks via a ration method using EPA's tap water regional screening levels (RSLs) "are likely orders of magnitude higher than the actual risks that would occur due to the limited exposure to surface water either receptor [recreational users and construction workers] would have." A semi-qualitative analysis to support this statement could be included in a revised version. The semi-qualitative analysis could include a comparison of values for key exposure parameters. For example, a comparison of the ingestion rate, surface area, and exposure frequency parameters for an adult resident and an adult recreational user can show that the tap water RSLs overestimate the recreational user assumptions by approximately two to three orders of magnitude.*

PGL Response: A semi-quantitative analysis has been added to Section 4.1 of the BLRA (Revision 2) to better clarify how the use of the tap water RSLs to assess surface water contact for recreational users overestimates the actual risk recreational users of the North Branch Chicago River would have if they contact the surface water. A comparative analysis of key exposure assumptions, including ingestion rate, exposure frequency, and surface area of skin contacted, are provided to put the conservative nature of the assessment into perspective.

Agency Specific Comment 3c: *The BLRA states that the risk assessment was prepared consistent with the EPA approved Multi-Site Risk Assessment Framework (RAF) (Exponent, Inc. 2007). The RAF notes that the bioavailability of polycyclic aromatic hydrocarbons (PAHs) in sediments are influenced by the organic carbon content in the sediments. The RAF references U.S. EPA guidance (EPA 2003) that provides a protocol to calculate an equilibrium partitioning sediment benchmark toxicity unit (ESB SUM-TU) for a sediment sample. Section 7.4 of the RAF states this guidance will be used to develop toxicity scores for each sediment sample. However, the ecological risk assessment used bulk PAH sediment data for screening purposes and did not calculate an ESB SUM-TU and use that data in the screening process as stated in the RAF. The ecological risk assessment used a similar protocol (EPA 2008) to calculate ESB SUM-TUs for petroleum volatile organics (benzene, ethylbenzene, toluene, and xylenes) in sediment samples. Please revise the BLRA to include the assessment of ESB-SUM-TUs for the sediment samples in the ambient locations and each of the study locations of OU2 or provide further justification to support this decision.*

PGL Response: Section 1.1 of the BLRA (Revision 2) was updated to explain why ESB SUM-TU calculations were not performed for PAHs but were performed for benzene, toluene, ethylbenzene, and xylenes (BTEX) detected in sediments. This explanation was also included in other applicable sections of the BLRA (Revision 2) for clarity (e.g., Sections 5.3.1 and 6.2) and summarized in Section 5.2 of the RI Report, Revision 2.

Considering the results of the ecological screening assessment and the toxicity testing performed in the ambient area of the North Branch Chicago River it was already known that sediments in the ambient area of the river were moderately toxic the benthic invertebrates unrelated to the presence of the MGP sites. For this reason, the ESB SUM-TU methodology was not used to predict the toxicity of PAHs in each of the sediment samples because the ambient PAH conditions of the river were already considered toxic to benthic invertebrates based on these other lines of evidence. However, many of the BTEX compounds detected in the ambient sediments were at concentrations lower than that considered potentially toxic in benthic invertebrates, and so the ESB SUM-TU calculations were performed for the investigative sediment samples to evaluate whether the concentrations of BTEX detected would pose a potential risk to benthic invertebrates.

Agency Specific Comment 3d: *Section 2, Page 4, Paragraph 2. The first sentence states that Figure 1 (the refined site-specific conceptual site model [CSM]) displays "potential transport mechanisms." Figure 1 shows only arrows between primary and secondary media; Figure 1 does not clearly identify what these arrows represent (for example, erosion, runoff, groundwater-surface water interaction, etc.). Figure 1 should be revised to clearly identify the potential transport mechanisms. Alternatively, Section 2 could be revised to explain the various transport mechanisms.*

PGL Response: As stated in the first paragraph of Section 2, "Figure 1 is a matrix that shows the different exposure pathways that are potentially complete under current and potential future site conditions for each receptor." While the potential transport mechanisms discussed in Section 5.3.1 of the RI report were considered when developing the matrix presented in Figure 1, the arrows linking different media are used to convey which media can potentially affect another media via these potential transport mechanisms. A footnote was added to Figure 1 in the BLRA (Revision 2) to clarify this point and to direct the reader to Section 5.3.1 of the RI report where they can find more details about the potential transport mechanism that may be applicable for each medium evaluated. In addition, the text of paragraph two of Section 2 was updated in the BLRA

(Revision 2) to cross-reference this same section of the RI report.

Agency Specific Comment 3e: *Section 2.1, Page 4, Paragraph 3. Section 2.1 discusses potential MGP-related constituents and refers to Section 4.0 of the RI report text. For clarity and ease of use for the reader, the list of medium-specific MGP-related constituents were provided as an attachment to the BLRA.*

PGL Response: The table of site-specific MGP-related constituents of potential concern (COPCs) by OU2 area (i.e., Willow Street, Division Street and North Station) in the RI report was also included in Section 2.1 of the BLRA (Revision 2) for clarity and ease of review of the report.

Agency Specific Comment 3f: *Section 2.3.1.2, Page 6. Footnote 1 indicates that further assessment of a small area on the east bank near North Station "was not considered necessary," due to its inaccessibility and small size (approximately 5 ft by 75 ft). Please provide further information on the inaccessibility of this area. A map may be useful to provide a visual reference.*

PGL Response: In Section 2.3.1.2, a cross-reference to a new Figure 5 which includes an inset with a photograph of the area was added to the BLRA (Revision 2) to provide a visual representation of where the small, wadeable area is located and to show that the area is not easily accessible because of the rock rip rap located along the shoreline in this area. The inaccessibility of this area was also discussed in Section 2.3.1.2 of the BLRA (Revision 2).

Agency Specific Comment 3g: *Section 3.1.3, Page 9. Four ambient surface water samples, and no duplicates, were collected for the North Station OU2. However, duplicate ambient surface water samples were collected for both Division Street OU2 and Willow Street OU2. Please provide further information on the sampling protocol and collection of duplicates for the surface water ambient samples obtained for North Station OU2.*

PGL Response: Surface water duplicates correspond to parent sample numerical count rather than particular OUs. Two surface water sampling events, which included collecting samples across all OU2s, were completed as part of this RI. The first was complete on December 12 and 14, 2011 and the second was completed between November 12 and 14, 2012. A total of 16 and 20 surface water samples were collected, respectively. As detailed in the Multi-Site Quality Assurance Project Plan (Integrys Business Support [IBS], 2007) and Field Sampling Plan Standard Operating Procedure SAS-04-03 Quality Control Samples (IBS, 2008), "*one duplicate sample will be collected per every 10 aqueous investigative samples*". Accordingly, two surface water duplicate samples were collected as part of each sampling mobilization.

Agency Specific Comment 3h: *Section 4.3, Pages 23 and 24. Section 4.3 discusses uncertainties associated with the human health risk assessment results. This section should be revised to include the uncertainty associated with the use of tap water RSLs to characterize potential recreational user and construction worker surface water-related risks and hazards. The revised text should also include the inclusion of a semi-quantitative analysis of the magnitude of this uncertainty.*

PGL Response: As discussed in the response to Comment 3b, a semi-quantitative analysis was added to Section 4.1 of the BLRA (Revision 2) to address the uncertainty associated with the use of tap water RSLs to characterize potential recreational user and construction worker surface water-related risks. This semi-quantitative analysis is also cross-referenced to and discussed in Section 4.3 of the BLRA (Revision 2).

Agency Specific Comment 3i: *Section 5.3.1, Page 34, Paragraph 2. The RAF stated that EPA guidance (EPA 2003) would be followed and an ESB SUM-TU would be calculated for each sediment sample as part of the screening process. This procedure was not completed, and no explanation was provided to justify why it was not done. Please revise the BLRA or provide further justification to support this decision.*

> **PGL Response:** Please refer to the response to Comment 3c. In addition, the explanation for the approach taken was also provided in the second paragraph of Section 5.3 of the BLRA (Revision 2), as well as other pertinent subsections of Section 6.0.

Agency Specific Comment 3j: *Section 7, Pages 60 and 61. Please review and update the list of references provided in Section 7, as the citation to "EPA 2015" listed on page 11 does not appear to be included.*

> **PGL Response:** The list of references in Section 7 of the BLRA (Revision 1) was accurate, but the reference to "EPA 2015" in the text of the report has been removed from the BLRA (Revision 2) as it is not applicable.

If you have any questions regarding the content of this letter or wish to discuss this matter further, please do not hesitate to contact me at (312) 240-4569 or Narendra.Prasad@WECEnergyGroup.com.

Regards,

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Manager Remediation & Waste – Environmental

Enclosures: Remedial Investigation (RI) Report – Revision 2 (dated July 24, 2019)

cc: Robert Paulson – WEC Business Services (via email)
Christopher Peters, IEPA (via email and two hard copies via FedEx)
Patrick Kenny, OBG, part of Ramboll (via email)

Remedial Investigation Report
Revision 2

The Peoples Gas Light and Coke Company
North Branch of the Chicago River Willow Street Station, Division Street Station and North Station Operable Unit 2, North Branch Site
Chicago, Illinois

WEC Business Services, LLC

July 24, 2019

OBG
Part of Ramboll

JULY 24, 2019 | PROJECT #67862

Remedial Investigation Report Revision 2

The Peoples Gas Light and Coke Company
North Branch of the Chicago River Willow Street Station,
Division Street Station and North Station Operable Unit 2,
North Branch Site
Chicago, Illinois

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Appendix I Baseline Risk Assessment Revision 2
Appendix J Chemical Properties and Persistence of COPCs

ACRONYMS AND ABBREVIATIONS

^{0}C	degrees Celsius
^{0}F	degrees Fahrenheit
µg/L	micrograms per liter
AOC	Administrative Order on Consent
ARA	adjacent river area
ASE	American Surveying and Engineering
ASTM	ASTM International, Inc.
ATSDR	Agency for Toxic Substances and Disease Registry
B&McD	Burns & McDonnell Engineering
bgs	below ground surface
BLRA	baseline risk assessment
BTEX	Benzene, toluene, ethylbenzene, xylenes
BTU	British Thermal Unit
CA	coarse aggregate
Canal	North Branch Canal
CAWS	Chicago Area Waterway System
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CF	cubic foot
CY	cubic yard
City	City of Chicago
COC	constituent of concern
COPC	constituent of potential concern
ComEd	Commonwealth Edison
CSM	conceptual site model
CSO	combined sewer outfall
CWG	carbureted water gas
DGPS	differential global positioning system
DNAPL	dense non-aqueous phase liquid
DNR	Department of Natural Resources
DOE	City of Chicago Department of Environment
EcoCAT	Ecological Compliance Assessment Tool
EPA	Environmental Protection Agency
ERA	Ecological Risk Assessment
FS	feasibility study
fps	feet per second
FSP	Field Sampling Plan
GC/FID	gas chromatograph/flame ionization detector
GC/MS	gas chromatograph/mass spectrometer
GPS	Global Positioning System
GSI	Groundwater-surface water interface

Hanson	Hanson Engineering Incorporated
HARGIS	Historic and Architectural Resources Geographic Information System
HASP	Health and Safety Plan
HHRA	Human Health Risk Assessment
HLC	Henry's Law constant
HSA	hollow stem auger
IAC	Illinois Administrative Code
IBS	Integrys Business Support, LLC., Inc.
IDOT	Illinois Department of Transportation
IDW	Investigation-derived wastes
IGLD	International Great Lakes Datum
IGLD55	International Great Lakes Datum of 1955
IGLD85	International Great Lakes Datum 1985
LUST	leaking underground storage tank
MDL	method detection limit
mg/kg	milligrams per kilogram
mgd	million gallons per day
MGP	manufactured gas plant
mL	milliliter
MS/MSD	matrix spike/matrix spike duplicate
MWRD	Metropolitan Water Reclamation District
NAD83	North American 1983 Datum
NAVD88	North American Vertical Datum of 1988
NAPL	non-aqueous phase liquid
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NOAA	National Oceanic and Atmospheric Administration
NFR	no further remediation
NRT	Natural Resource Technology, Inc.
OBG	O'Brien & Gere Engineers, Inc., part of Ramboll
OSFM	Office of the State Fire Marshal
OU	Operable Unit
PAH	polycyclic aromatic hydrocarbon
PCA	physical characterization assessment
PCB	polychlorinated biphenyl
PGL	People's Gas Light and Coke Company
PID	photoionization detector
PIN	Parcel identification number
Pioneer	Pioneer Engineering & Environmental Services
PVOC	petroleum volatile organic compound
QA/QC	quality assurance/quality control
QAPP	Quality Assurance Project Plan
RACR	Remedial Action Completion Report

RAF	Multi-Site Risk Assessment Framework
RI	Remedial Investigation
River	North Branch of the Chicago River
ROW	right-of-way
RPD	relative percent difference
RSL	Regional Screening Level
SARA	Superfund Amendments and Reauthorization Act
Site	North Branch Site
SI	site investigation
SIM	selected ion monitoring
SL	screening level
SOP	Standard Operating Procedure
SOW	Statement of Work
SRP	Site Remediation Program
SSWP	Site-Specific Work Plan
TACO	Tiered Approach to Corrective Action Objectives
TarGOST	Tar-Specific Green Optical Screening Tool
TARP	Tunnel and Reservoir Plan
TOC	total organic carbon
TPAH	total polycyclic aromatic hydrocarbons
USACE	United States Army Corp of Engineers
USEPA	United States Environmental Protection Agency
UST	underground storage tank
UTL	upper tolerance limit
VOC	Volatile organic compound
WBS	WEC Business Services, LLC
WMI	Waste Management, Inc.

1 INTRODUCTION

1.1 PURPOSE OF REPORT

This report presents the Remedial Investigation (RI) Site Investigation (SI) work completed in the North Branch Chicago River (River) at The People's Gas Light and Coke Company's (PGL) North Branch Site (Site) (Figure 1). The RI activities and reporting were performed pursuant to the Administrative Order on Consent (AOC) and Statement of Work (SOW), Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) Docket No V-W-08-C-917, effective October 31, 2008. The AOC and SOW addresses four former PGL manufactured gas plant (MGP) sites located in Cook County, Chicago, Illinois (North Shore Avenue Site, North Branch Site, Crawford Site, and South Branch Site). The Site comprises of the Willow Street Station (Willow Street) Former MGP, the Division Street Station (Division Street) Former MGP, and the North Station Former MGP. This RI also incorporates data obtained from the concurrent River ambient investigation (Figure 1).

In previous documents, the river areas adjacent to the former MGPs were referred to as the adjacent river areas (ARAs). Following a recent email from the United States Environmental Protection Agency (USEPA) dated July 11, 2018, the upland and river areas of the Site will be referred to as follows:

- Operable Unit 1 (OU1) refers to the upland and groundwater portion of the former MGPs.
- Operable Unit 2 (OU2) refers to the river portion of the former MGPs.

This RI Report discusses the results obtained during investigation of the OU2s associated with the three former MGPs (Willow Street, Division Street, and North Station) located within the Site (Figure 2). Separate RI Reports will be submitted for the upland OU1s in the future.

Work described at the Willow Street OU2. herein. was completed in accordance with the USEPA-approved Site-Specific Work Plan (SSWP), Revision 2, prepared by Natural Resource Technology, Inc. (NRT) (NRT 2011b). Work described at the Division Street OU2. herein. was completed in accordance with the USEPA-approved SSWP, Revision 1, prepared by NRT and Burns & McDonnell Engineering (B&McD) (B&McD 2009b). Work described at the North Station OU2, herein, was completed in accordance with USEPA-approved SSWP, Revision 0 (NRT 2011), along with the Revision 1, as modified (NRT 2012).

The work plan for the activity described in the ambient investigation area. Herein. was completed in accordance with Characterization of Ambient Conditions in the Chicago River Upstream from the North Branch MGP Site (Revision 1) (Exponent 2009); the technical memorandum, Supplement to Characterization of Ambient Conditions in the Chicago River Upstream of the North Branch MGP Site (Exponent 2010); and the SSWP Revision 1 (NRT 2012), used for Step I work at North Station.

Previous investigation activities and remedial actions are summarized in the following documents: Willow Street and surrounding areas are discussed in the Completion Report, Willow Street/Hawthorne Avenue (B&McD 2009), and the SSWP, Revision 2 (NRT 2011b); Division Street is discussed in the Completion Report, Division Street Station (B&McD 2008); and North Station is discussed in the Completion Report, Peoples Gas Light and Coke Company, Former North Station Manufactured Gas Plant Site (NRT 2011c). Previous remedial action activities are further discussed below in Section 1.9.

Based on the conclusion of information in the Completion Reports, a site-specific technical approach was developed and presented in the SSWPs to assess existing media and/or areas that may pose a potential risk to human health and/or the environment on the Site. This RI Report presents sediment and surface water data collected as part of the field RI activities between March, 2011, and December, 2013 (archived samples were analyzed in April, 2014).

All work was completed in accordance with applicable federal regulations, including CERCLA (or "Superfund"), as amended by the Superfund Amendments and Reauthorization Act (SARA), and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP).

1.2 WORK OBJECTIVE

The overall objective of the RI activities was to evaluate the nature and extent of potential remaining MGP residuals in sediment and surface water in the River, and support human health risk assessments (HHRA) and ecological risk assessments (ERA). The RI results will be used to evaluate whether further evaluation or remedial actions are warranted at the Site. The evaluation of remedial actions, if necessary, will be presented in the Feasibility Study (FS).

MGP residuals were identified (in past investigations) in and around former upland MGP structures, in subsurface soil in the OU1s, and in sediments within the OU2s. Various media required further assessment with respect to public health, welfare, or the environment based on the prior work, as described in the site SSWPs. Media addressed as part of this RI are summarized below.

- Surface water sampling was performed to assess: (1) the characteristics of the River (*i.e.*, bathymetry), and (2) the distribution of constituents of potential concern (COPCs) and the potential risk to human health and the aquatic environment.
- Sediment sampling was performed to assess the distribution of COPCs and the potential risk to human health and the aquatic environment. In addition, geotechnical parameters were collected to support future FS efforts.

1.3 SITE BACKGROUND

The Site comprises the OU2s adjacent to Willow Street OU1 and Division Street OU1 on the River, and the former North Station OU1 on the North Branch Canal (Canal) (Figure 2). The River and Canal in these areas do not have a Parcel Identification Number (PIN), nor are they zoned. The OU2s are part of a public waterway and information and descriptions are included below for the upland and river OUs within the Site.

1.3.1 Site Location

The River is part of the Chicago Area Waterway System (CAWS), which is 100 miles of rivers and canals connecting Lake Michigan with the Mississippi River, via the Lower Des Plaines and Illinois Rivers. CAWS is an entirely engineered waterway; water depth and flow are controlled by a series of locks. Land use within the CAWS basin is generally urban, with extensive industrial development. The basin surrounding the CAWS includes the City of Chicago (City) and 31 suburban municipalities. Flow in the CAWS is dominated by treated wastewater from five large water reclamation plants (WRP), serving 5 million residents and an additional industrial load of approximately 4.5 million population equivalents. Approximately 70% of inflow to CAWS is from the WRPs (Metropolitan Water Reclamation District [MWRD], 2018).

CAWS was developed with a combined sewer system that accepts both storm water and sanitary waste. After rainstorms, the capacity of the sewer system can become overwhelmed and combined sewer overflows can occur. There are approximately 58 active outfalls present within the Site, and a number of them are combined sewer outfalls (CSOs). CSO overflow event history is available on MWRD's website (http://www.mwrd.org) for the period dating from April 1, 2016, to June 28, 2018. During this period, there were 788 CSO overflow events in the River at 16 different CSOs, including 438 CSO events at CSOs located upstream from the Site. Sixty-two CSO events were recorded during this period at the Fullerton Avenue CSO located immediately upstream of the Site.

To address the CSO overflow problem, MWRD developed the Tunnel and Reservoir Project (TARP), or "Deep Tunnel" project, which includes the construction of tunnels and reservoirs to provide additional water storage and reduce CSO overflow events. During periods of heavy rainfall, the TARP directs combined sanitary waste and infiltrating rainwater into massive, deep tunnels and collection reservoirs, where it can be withdrawn for treatment after the rain subsides, thus reducing, but not eliminating, the amount of CSO overflow events (MWRD 2018). The first phase of the TARP, installation of tunnels, was completed in 2006. TARP reservoir construction is ongoing and is expected to be completed by 2029. According to MWRD's TARP Fact Sheet, since the tunnels became operational, CSOs have been reduced from an average of 100 days per year to 50 across the entire CAWS

(MWRD 2018). Further reduction is expected as reservoir construction is completed. The three OUs of the Site are described in more detail below.

1.3.2 Willow Street Former MGP Location and Description

The Willow Street OU1 (Figure 3A) covers approximately 3.4 acres and is located west of the intersection of North Kingsbury Street and West Willow Street. OU1 is bounded by the River to the west, industrial/commercial properties to the north and south, and North Kingsbury Street to the east. The upland OU consists of the following parcels:

- General Iron Parcel - A 3.3-acre portion of the Willow Street OU1, located west of North Kingsbury Street. This parcel is occupied by General Iron and is currently used as a staging area for unprepared steel. The parcel consists of a gravel covered lot, a truck scale, and a bio-swale. A chain-link fence restricts access to the parcel.
- AFS Parcel (formerly A. Finkl Parcel) - A 0.1-acre portion of the Willow Street OU1, located west of North Kingsbury Street. The AFS Parcel covers approximately 0.57 acres, but only 0.1 acre of the property was a portion of the MGP. This parcel is unimproved and is currently being used by General Iron for storage. A chain-link fence restricts access to the parcel.

The Willow Street OU2 (River) is the most northerly of the Site and covers approximately 3.9 acres. OU2 ranges from 540 feet upstream to 450 feet downstream of the upland OU1. At its widest point, the OU2 is approximately 225 feet wide and is bordered to the east and west by sheet pile walls. The upland OU1 is on the River's east bank. Industrial and commercial properties border the River OU2. The Willow Street Former MGP layout is presented in Figure 3A. The former MGP site location and identification information is summarized below:

Former MGP Operator:	The Peoples Gas Light and Coke Company Contact: Mr. Naren Prasad 200 East Randolph Drive Chicago, Illinois 60601
General Iron Parcel Owner:	General Iron Industries Inc. Contact: Ms. Marilyn Labkon 30 North LaSalle Street, 25th Floor Chicago, Illinois 60602
AFS Parcel Owner:	GI North Property LLC 1919 North Clifton Avenue Chicago, Illinois 60614-4803
Facility Locations:	Section 32, Township 40 North, Range 14 East 1640 North Kingsbury Street (General Iron) 1740 North Kingsbury Street (AFS) Chicago, Illinois Cook County
USEPA CERCLIS ID	ILD982074759
Site Spill ID Illinois Environmental Protection Agency (Illinois EPA)	Site Spill ID – B5FY LPC 0316075229

1.3.3 Division Street Former MGP Location and Description

The Division Street upland OU1 (Figure 3B) encompasses approximately 18.2 acres and is located south of the intersection of West Division Street and North Elston Avenue. The upland OU1 is bounded by West Division Street to the north, the River to the east, West Cortez Street (formerly Wade Street) to the south, and the Chicago

and Northwestern Railroad to the west (Figure 3B). North Elston Avenue runs north to south through the former MGP, dividing the OU1 into the Western Property and the Eastern Property. The Western Property is owned and used by PGL as a meter testing, maintenance, and office facility. The northern parcel of the Eastern Property is developed with a commercial restaurant/bar (the Bar Parcel) and the southern parcel is currently vacant, but was formerly used as a boat storage yard and marina (the Boatyard Parcel). The City owns the Boatyard Parcel and intends to develop it as a park.

The Division Street OU2 consists of approximately 17.5 acres, 300 feet upstream of the upland OU1, 1,300 feet downstream, and approximately 200 feet wide, and is bordered to the east and west by sheet pile walls. Goose Island borders the eastern side of OU2. The former MGP site location and identification information is summarized below:

Former MGP Operator:	The Peoples Gas Light and Coke Company Contact: Mr. Naren Prasad 200 East Randolph Drive Chicago, Illinois 60601
Western Property Owner:	The Peoples Gas Light and Coke Company Contact: Mr. Naren Prasad 200 East Randolph Drive Chicago, Illinois 60601
Boatyard Parcel Owner:	The City of Chicago Contact: Ms. Kimberly Worthington 30 North LaSalle Street, 3rd Floor Chicago, Illinois 60602-2590
Bar Parcel Owner:	Mr. Jacqulin Pele 1368 West Evergreen Chicago, Illinois 60622
Site Location:	Section 5, Township 39 North, Range 14 East 1241 West Division Street (Western Property) 1111 North Elston Avenue (Boatyard Parcel) 1117 North Elston Avenue (Bar Parcel) Chicago, Illinois Cook County
USEPA ID **Illinois EPA ID:**	ILD982074783 0316005885

1.3.4 North Station Former MGP Location and Description

The upland portion of the North Station former MGP (Figure 3C) encompasses approximately 6.47 acres and is located south of the intersection of West Division Street and North Crosby Street. The upland OU1 is bounded by a commercial property and West Division Street to the north, North Crosby Street and residential properties to the east, West Hobbie Street and residential properties to the south, and the west edge of the vacated North Kingsbury Street to the west. The upland OU1 is currently occupied by an active Commonwealth Edison (ComEd) substation (ComEd Parcel) and residences (Old Town Village West Parcel).

The North Station OU2 is within the manmade Canal and covers approximately 6.4 acres, 330 feet upstream of the upland OU1, 400 feet downstream, and approximately 150 feet wide, and is bordered to the east and west by sheet pile walls. Goose Island borders the west boundary of OU2. The individual parcels of the North Station

former MGP are shown on Figure 3C. The former MGP site location and identification information is summarized below:

Former MGP Operator:	The Peoples Gas Light and Coke Company Contact: Mr. Naren Prasad 200 East Randolph Drive Chicago, Illinois 60601
ComEd Parcel:	ComEd Contact: Mark Castro Two Lincoln Centre Oakbrook Terrace, Illinois 60181-4260
Old Town Village West Parcel:	Chicago Housing Authority 60 E Van Buren St. Fl 12 Chicago, IL 60605
Facility Location:	Section 4, Township 39 North, Range 14 East Chicago, Illinois Cook County
USEPA ID:	ILD982074775

1.4 SITE HISTORY

The following sections detail the historic developments at the Site upland OU2s and relevant adjoining properties.

1.4.1 Willow Street Former MGP History

The history of the upland Willow Street OU1 (Figure 4A) was compiled by reviewing Sanborn maps, historic topographic maps, aerial photographs, facility "skeleton" diagrams, and previous reports. The results of a regulatory database search for the OU and surrounding area were also reviewed to help define potential sources of impacts.

Based on historic information, the Ogden Gas Company constructed the former Willow Street Station MGP between 1895 and 1897 to produce low-British Thermal Unit (BTU) gas using the carbureted water gas (CWG) method. Details of the former MGP process are provided in the Completion Report (B&McD 2009) and the SSWP, Revision 2 (NRT 2011b). Historical structures for the production facility are shown on Figure 4A, and specific structures on the General Iron Parcel included the following:

- Two (2) gas holders (420,000 and 100,000 cubic foot [CF])
- A 70,000-gallon oil tank
- Two (2) tar tanks (73,000 and 158,000 gallons)
- Two (2) tar wells
- Two (2) scrubbers
- A purifying house
- Hydrometers
- A production building that housed generators, carburetors, super heaters, scrubbers, condensers, and engines
- A coal shed, coke pile, and other buildings

A coke pile storage area was identified north of the production area. The northern boundary of the coke pile storage area was located on a strip of the AFS Parcel, immediately north of the General Iron Parcel.

A 2,500,000-CF gas holder was located on the southern portion of the Marcey Parcel, on the historic Hawthorne Avenue portion of the OU1. A 5,000,000-CF water-sealed gas holder was located on the ComEd Parcel with the southeastern edge of the holder, piping and the drip oil tank extending into the PGL Parcel. A compressor building was located on the western portion of the PGL Parcel and the southwest corner of the ComEd Parcel.

In 1907, PGL began leasing the property from the Ogden Gas Company. Operations to phase out production began in 1910 and production activities ceased in 1921. The gas holders east of North Kingsbury Street remained and by 1935, a boiler and engine house (now used as a retail store) was added to the northeast corner of the Marcey Parcel, and an automobile shop building, which included a gasoline tank in the northwest corner, was added to the east side of the parcel, along North Marcey Street.

Most of the aboveground structures of the production facility were dismantled by 1938, and the original gas holders were dismantled in 1944. PGL acquired a portion of Ogden Gas Company and later began leasing portions of the former Willow Street MGP property (General Iron Parcel) in 1944 and selling portions in 1947. Between 1949 and 1951, PGL leased a portion of the Willow Street former MGP property to Construction Aggregates Company, later Material Services Corporation and E.L. Hedstrom Coal Company, for the storage of construction-related materials and coal.

The General Iron Parcel was reactivated by PGL as a storage and distribution station in 1953. A 17,000,000-CF tar-sealed (waterless) gas holder was constructed over the former production facilities. The gas holder had a diameter and maximum height of approximately 225 feet and 339 feet, respectively. The 17,000,000-CF gas holder was taken out of service in 1972 and is no longer depicted on the aerial photograph by 1984.

1.4.2 Division Street Former MGP History

The Division Street Station OU1 (Figure 4B) was constructed in 1883 as a water gas production and storage facility with a 1,000,000-CF water-sealed gas holder and a 500,000-CF relief holder. In 1888, an additional 3,000,000-CF gas holder was constructed on the northern portion of the Western Property. The facility was operated by the Illinois Light, Heat and Power Company from 1885 until 1897, when the company consolidated with PGL. In 1929, a 10,000,000-CF tar-sealed gas holder was constructed on the southeast corner of the Western Property.

Based on a 1933 skeleton map of the MGP, and the historic Sanborn fire insurance maps, all of the historic MGP process structures were located on the Western Property. Underground structures associated with the historical MGP operations included the relief holder, storage tanks, oil tanks, tar tanks, tar settling tanks and a tar sewer. The skeleton map also indicates two (2) surface water intake pipes connected to the River, one of which was converted to a sewer discharge pipe leading back to the River. Additional sewer pipes were located along Division Street and Elston Avenue and discharged storm and sanitary effluent to the City combined sewer system.

Aboveground structures included buildings, gas holders, purifiers, condensers, shaving scrubbers, oil tanks, and light oil washers. The Eastern Property was formerly used as a coke storage area and MGP process structures were not located in this area, based on historical maps. However, a tar sewer is shown on the skeleton map leading from the Western Property, in the area of the former tar wells, to the River, crossing the Eastern Property near the boundary between the Bar and Boatyard Parcels.

The 1,000,000-CF gas holder was damaged in 1930 when an airplane crashed through the crown. This holder was dismantled in 1931. In 1933, various oil gas processes were experimented with on the MGP and a high BTU CWG process was adopted in 1936. In 1944, the MGP was modified to produce reformed natural gas by mixing manufactured and natural gasses. Figure 4B presents the layout of the OU with historical MGP structures. Gas production at the plant ceased prior to 1962, when the aboveground structures were dismantled and removed.

Since 1962, the Western Property has been used as a PGL meter repair, maintenance, and office facility that services the Chicago area. Current features of the facility include a meter shop, a maintenance building, warehouse and storage buildings, material storage bins, office buildings, one 12,000-gallon gasoline underground storage tank (UST) and one 12,000-gallon diesel fuel UST. The USTs were installed in 1979 and are made of fiberglass. They are currently registered with the Office of the State Fire Marshal (OSFM) in Illinois and have not had any reported leaks. Former USTs at the Site have included a 550-gallon used oil UST, a 15,000-gallon gasoline UST, and a 1,500-gallon diesel fuel UST. The 550-gallon used oil UST was installed in 1979 and removed in 1995. The 15,000-gallon gasoline and 1,500-gallon diesel fuel USTs were installed in 1965, abandoned in place in 1979, and subsequently removed during the 2004 to 2005 remediation activities (discussed further in Section 1.9.2).

The northern portion of the Eastern Property (the Bar Parcel) is occupied by a commercial restaurant/bar, which was established in approximately 1989. The current occupant is the "Estate Ultra Bar." The southern portion of the Eastern Property (the Boatyard Parcel) was occupied by the AAA Boatyard, Inc., as a boat storage yard, and as a marina from approximately 1989 to 2003. However, the City purchased the Boatyard Parcel in 2003 and the parcel is currently vacant. The City of Chicago Department of Environment (DOE) enrolled the Boatyard Parcel into the Illinois EPA Site Remediation Program (SRP) in January 2005 to facilitate redevelopment of the property as a park and canoe launch.

1.4.3 North Station Former MGP History

Precursors to PGL built the North Station OU1 facility (Figure 4C) in 1868 for the production of coal gas. Coal gas production involved heating coal in an airtight chamber (retort) and driving off volatile organic compounds (VOC) as a gas. The gas was then passed through purifiers to remove impurities. such as sulfur, carbon dioxide, cyanide, and ammonia. The purifiers used trays and sieves containing lime or hydrated iron oxide mixed with wood chips. The gas was then stored in large pressure-relief holders on site, prior to distribution for lighting and heating.

In 1887, production was converted to a CWG process. This process involved passing air and steam over incandescent coal in a brick-filled vessel to form a combustible gas. which was then enriched by spraying a fine mist of oil over the bricks. The gas was then purified and stored in holders prior to distribution. Production of manufactured gas created several different by-products and wastes, such as various forms of tar, sludges, coke, ash, wood chips, and spent oxide/lime.

The MGP facility was closed in the early 1960s. Former MGP-related structures and pertinent historical features on the ComEd and adjacent parcels are summarized on Figure 4C. The primary MGP structures included the following:

- Main gas production and retort buildings
- Purifying house
- 1.5 million-CF gas holder
- Two 500,000-CF relief holders
- 750,000-gallon oil tank as well as underground oil tanks
- Tar settling wells, tar extractors, and a tar tank
- Naphtha tank
- Oil condensers
- Pumps and scrubbers
- Ash hopper
- Various equipment and storage buildings

The area that was used for coal storage on the two adjacent parcels along the Canal is shown on Figure 4C. The 1910 Sanborn map (Appendix A1 of the SSWP, Revision 1 [NRT 2012]) shows the Division-Halsted and LaSalle-Chestnut parcels as a 50,000-ton coke shed owned by PGL. Kingsbury Street was formerly occupied by C.M.St.P&P railroad tracks from prior to 1910 to at least 1990.

The 1910 Sanborn map also shows offices and storage buildings on the Old Town Village West parcel, as well as a building containing a tar vat that was apparently used for "pipe dipping." An adjacent building was identified as a "Pipe W.Ho. [Warehouse]." The building containing the tar vat and the pipe warehouse are not shown on the 1935 Sanborn map and the property is identified as a contractor's equipment yard.

1.5 SURROUNDING AREA USE

1.5.1 Willow Street OUs

The area surrounding the Willow Street OUs is currently occupied by industrial and commercial properties. A building is present immediately north of the AFS Parcel, which currently houses a fitness center. This building is present on the historical Sanborn maps next to the tank farm. Additional property owned by GI North Property, LLC, used for scrap metal processing, is immediately south of the General Iron Parcel. City Scrap Metal, LLC, a commercial scrap metal facility, is located north of the ComEd Parcel and West Wisconsin Street. Commercial properties are located east of North Marcey Street, including the Goose Island Brewery, shops, offices, and the mixed-use Clybourn Galleria, which houses a self-storage facility, children's day care facility, restaurant, and other commercial businesses. Additional commercial properties (a home electronics retailer, grocery store, and other shops) are present south of West Willow Street. Zoning districts for the area surrounding the Willow Street OU are depicted in Figure 5.

Historically, the surrounding areas were mainly industrial, with bulk oil stations, foundries, steel mills, coal storage, breweries, lumber yards, brick manufacturer, metal scrap yards, and a variety of other manufacturers. The north adjacent land was occupied by the Texas Company Bulk Oil Station, a bulk oil terminal, with many associated buildings and numerous buried tanks. Great Lakes later acquired the property and operated a solvent handling operation. Properties south and southeast were formerly operated as a coal yard, metal foundry, lumber yard, brewer machine manufacturing plant, and plastics factory (Hanson Engineering Incorporated [Hanson] 1991). Historic businesses east of the former Willow Street OU have included a paint and solvent company, a bulk oil station (fuel product) company, a metal springs manufacturing plant, a can manufacturing plant, and a baking company (Hanson 1992). The bulk oil station has been identified to have had at least three buried fuel oil tanks along North Kingsbury Street.

1.5.2 Division Street OU

The area surrounding the Division Street OUs is currently occupied by commercial and industrial properties. Immediately north of the OU, across Division Street, is a commercial car dealership property, followed by commercial and industrial manufacturing facilities. To the east of the OU2 is a commercial car dealership, followed by various commercial and shipping facilities adjacent to the River. South of the Division Street OU1 is the former Chicago Paperboard Corporation, followed by commercial garage and parking lots. Immediately west of the OU1 are railroad tracks, followed by Interstate 90/94. There are two commercial properties southwest of the OU, adjacent to Interstate 90/94. Zoning districts for the area surrounding the Division Street OUs are depicted in Figure 5.

Historically, surrounding properties were used for industrial and commercial purposes. Previous businesses north of the Division Street OUs have included a boiler manufacturing company, a varnish factory, a tanning company, and a service station. Historic properties south of the Division Street OU1 included a paint factory, a service station, and a vehicle garage (B&McD 2008).

1.5.3 North Station OU

The area surrounding the North Station OUs is currently occupied by commercial, industrial, and residential properties. To the north of the OU1 is a vacant grass lot and Division Street; north of Division Street is another vacant grass lot. East of OU1 are various multi-unit residential developments, followed by a municipal facility

and more residential and commercial properties. There are additional residential homes and commercial facilities to the southeast. West of the upland OU is the historic Division Halsted parcel (Section 1.3.4.2) followed by OU2. West of the Canal are a variety of commercial and industrial facilities. Zoning districts for the area surrounding the North Station OUs are depicted in Figure 5.

Historically, the surrounding areas were mainly used for residential, industrial, and commercial purposes. North of North Station OU1 was the location of the former Cabrini-Green Chicago Housing Authority public housing project. A former auto service station, former wood/coal storage facilities, and iron manufacturing facilities previously occupied the area west of the upland OU on the historic Halsted parcel, adjacent to the Canal. The area to the east of the OU was previously occupied by a junk yard and various manufacturing facilities. Historic properties to the south included various industrial and manufacturing facilities (NRT 2011c).

1.6 RIVER DESCRIPTION AND DREDGING HISTORY

The following section provides a description of the River and Canal and a summary of known dredging activities on the River within the Site. The Site is bound by the Chicago Avenue bridge to the south, to approximately 1,150 feet upstream of the North Avenue bridge to the north. The River (on the west side of Goose Island) and the Canal (on the east side of Goose Island) occupy portions of the Site (Figure 2).

The Canal, or Ogden's Canal, is manmade and was completed in 1857 through a clay excavation project. When originally constructed, it was 50 feet wide and 10 feet deep, allowing crafts navigating the River to avoid going around the bend on the west side of Goose Island.

The United States Army Corps of Engineers (USACE) is responsible for maintaining the navigational channel of the River within this area. Based on USACE, the federal channel for dredging on the North Branch only extends as far north as North Avenue. The project depth of the channel, from Michigan Avenue to North Avenue, is 21 feet, or channel bottom elevation of approximately 555.2 feet above mean water level, approximately 556.4 feet above mean sea level (North American Vertical Datum [NAVD88]) (elevations are based on the assumption that project depth is the depth below normal pool elevation at Father Point, Quebec [576.2 feet above mean water level]) (International Great Lakes Datum [IGLD] of 1955). USACE also reports that at some time the channel was maintained from North Avenue to Addison Avenue, at a project depth of 9 feet or approximately 567.2 feet above mean water level (IGLD of 1955 [IGLD55]), approximately 568.4 feet above mean sea level (NAVD88). IGLD55 elevations were converted to NAVD88 elevations using conversion equations provided on the Illinois Department of Natural Resources (DNR) (2014) and National Oceanic and Atmospheric Administration (NOAA) (2012) websites.

Documentation of historical dredging is sparse, but based on the USACE, it is reported that the River and Canal have not been dredged since 1966 (Appendix A2). The most recent dredging events on these water courses were focused primarily between Chicago Avenue and North Avenue, on both sides of Goose Island, and terminating at the northern turning basin downstream of North Avenue and the Willow Street OU. The last dredging event within this area occurred from June through August ,1966, by Fitz Simons & Connell Dredge & Dock, with a total of 159,113 cubic yards (CYs) of material removed. Based on USACE, prior to 1966, dredging occurred in 1963, 1961, and 1956, by both Fitz Simons & Connell Dredge & Dock and by Great Lakes Dredge and Dock, with a total of 122,929-CY, 421,395-CY, and 170,000-CY of material removed, respectively. Based on USACE, this dredging occurred prior to the construction of any confined disposal facilities; therefore, the dredged material was most likely disposed of along the shoreline or in Lake Michigan. As previously stated, the approximated project channel bottom elevation after dredging between Michigan Avenue to North Avenue was 556.4 feet above mean sea level (NAVD88).

To monitor the channel depth, USACE surveys the River from Michigan Avenue to Addison Avenue every three to five years. The channel was last surveyed in November, 2017.

Currently, commercial traffic within the River is regular but not heavy. Field observations indicate minimal daily tug and barge traffic for materials like gravel, stone, and salt. A water taxi passenger boat began operating on the North Branch River in 2013 from the Main Stem of the River to North Avenue seasonally, from May through October.

1.7 PREVIOUS SEDIMENT INVESTIGATIONS

Sediment quality in the Site OU2s has not been comprehensively investigated prior to this RI. Previous limited sediment investigations occurred during each respective upland RI, and are presented in Appendix A3 and are summarized below.

1.7.1 Willow Street OU2

2006 December, B&McD, *Draft-River Sediment Investigation Summary for the Former Willow Street Station, Chicago, Illinois.*

Objective:

Evaluate the presence of MGP residuals in the River adjacent to the Willow Street property. The investigation was completed on behalf of PGL.

Scope:

No data analysis or report narrative was prepared. Forty-five Tar-specific Green Optical Screening Tool (TarGOST) probes and 38 sediment borings were conducted within Willow Street OU2 in June and July of 2006, which confirmed the presence of potential MGP residuals (See Figure 11 in the SSWP, Revision 2 [NRT 2011b]). Screening of sediment using the TarGOST did not indicate potential MGP impacts to OU2 sediments, but forensic evaluations did suggest the presence of dense non-aqueous phase liquid (DNAPL).

Sediment samples collected from thirteen of the borings were submitted for forensic evaluations (B&McD 2006b). Visual evidence of DNAPL in the River was limited to one instance (when it appeared to be on the surface of an auger being extracted from the sediment [RSB019C, near the dock wall at the General Iron Parcel, currently OU2]), but no DNAPL was found in the associated sample. Analytical data from this sampling event was incorporated into this RI Report and is discussed further in Section 4.3 and 4.4. The 38 boring logs are presented in Appendix D6.

1.7.2 Division Street OU2

Initial investigations were conducted in the sediments of the River adjacent to the former MGP that document the presence of MGP residuals. The investigation performed is discussed below.

2007 April, B&McD, *Draft-River Sediment Investigation Summary, Former Division Street Station Manufactured Gas Plant Site, Chicago, Illinois.*

Objective:

Evaluate the presence of MGP residuals in the River adjacent to the Division Street property. The investigation was completed on behalf of PGL.

Scope:

No data analysis or report narrative was prepared. Seventy-one TarGOST probes were conducted, plus logs for two hollow-stem auger borings in February and March, 2007 (B&McD 2007). TarGOST probe depths ranged from approximately 13 to 22 feet below sediment surface. Boring logs indicate visual observations of tar. The report provides TarGOST probe logs, boring logs, and Environmental Laboratory Report (Meta Environmental, Inc., April 13, 2007) with results of six sediment samples analyzed by gas chromatograph/flame ionization detection (GC/FID) for fingerprinting and by gas chromatograph/mass spectrometry (GC/MS) and selected ion monitoring (SIM) for mono- and polycyclic aromatic hydrocarbons (PAHs), alkyl PAH homologues, and other selected compounds. The two boring logs are presented in Appendix D6.

1.7.3 North Station OU2

Initial investigations were conducted in the sediments of the Canal adjacent to the former MGP that document the presence of MGP residuals. The investigation performed is discussed below.

2006 November, B&McD, *Draft-River Sediment Investigation Summary, Former North Station Manufactured Gas Plant Site, LaSalle-Chestnut Property, Chicago, Illinois.*

Objective:

Evaluate the presence of MGP residuals in the Canal adjacent to the LaSalle-Chestnut and Division Halsted properties. The investigation was completed on behalf of PGL.

Scope:

No data analysis or report narrative was prepared. Thirty-three TarGOST probes were conducted in October, 2006. Probe depths ranged from approximately 20 to 30 feet below sediment surface. The report provides a sample location map and TarGOST probe logs.

2007 April, B&McD, *Draft-River Sediment Investigation Summary, North Station Former Manufactured Gas Plant Site, Chicago, Illinois.*

Objective:

Evaluate the presence of MGP residuals in the Canal adjacent to the LaSalle-Chestnut and Division Halsted properties. The document presents a sample location map and compiles data from the investigation completed on behalf of PGL.

Scope:

No data analysis or report narrative was prepared. The document provides a revised sample location map; re-issues the same 33 TarGOST probes conducted in October, 2006, plus logs for three hollow-stem auger borings in Canal sediment in March, 2007; two photos showing visual evidence of tar; Environmental Forensic Report (Meta Environmental, Inc. 2007) with results of three sediment samples analyzed by GC/FID for fingerprinting and by GC/MS/SIM for mono- and PAHs, alkyl PAH homologues, and other selected compounds (B&McD 2007b). The three boring logs are presented in Appendix D6.

1.8 SURFACE WATER INVESTIGATIONS

Surface water sampling has not been conducted as part of previous SIs. Surface water sampling was performed as part of this RI work as discussed in Section 3.8.

1.9 UPLAND OUS - PREVIOUS REMEDIAL ACTIONS

Extensive response and remedial actions have been completed on the associated Site upland OU1s and are summarized below.

1.9.1 Willow Street Upland OU

Remedial actions were conducted on the General Iron Parcel (current OU1, Figure 3A) between December, 2004, and April, 2006, and consisted of:

- The removal of all DNAPL and soil that exceeded the Illinois Tiered Approach to Corrective Action Objectives (TACO) Tier 1 residential and construction worker soil remedial objectives (ROs). Soil was excavated and removed from depths ranging from 3 to 21 feet below ground surface (bgs) (up to approximately 13 feet below the water table in the River) across the entire site. DNAPL was encountered at various depths during excavation activities and the deepest excavations were completed where the former tar wells were located. Any historical MGP structures (*e.g.*, concrete foundations and piping) encountered were removed during the remediation activities. An anchor wall was installed to brace the existing seawall prior to excavating along the River up to 18 feet bgs.

- Confirmation soil samples were collected following excavation activities, and the excavated areas were backfilled with unimpacted imported aggregate and topsoil. Details of the remedial action are presented in the Remedial Action Completion Report (RACR) included in Appendix C of the Completion Report (B&McD 2009).
- Remediation objectives were achieved with the removal of source material and the elimination of soil ingestion and inhalation exposure routes for both residential and construction worker land uses in accordance with the Illinois EPA SRP.
- During remedial activities on the General Iron Parcel, potential MGP residuals were identified in soil on the adjacent AFS Parcel. An SI was conducted and subsequent remedial actions were taken to remove affected soil from the AFS Parcel.

Remediation activities on the AFS Parcel (Figure 3A) consisted of:

- Excavating affected soil to depths ranging from 4 to 13 feet bgs (up to 7 feet below the water level in the River) across the entire site. Affected material was encountered at various depths during excavation activities and approximately 13,477 tons of affected material was excavated. Following excavation, areas were backfilled with unimpacted imported aggregate and confirmation soil samples were collected to demonstrate that remedial objectives were achieved.
- In addition, approximately 80 tons of polychlorinated biphenyl (PCB)-affected soil were excavated and disposed at The Environmental Quality Company Wayne Disposal, Inc., facility in Belleville, Michigan. Along the northern boundary of the AFS Parcel, what is believed to be petroleum-affected soil was present. These impacts are likely associated with a former bulk terminal (referred to in historical documents as Great Lakes Solvent Company, Great Lakes Terminal, and Texas Oil Co.) that was located directly north of the parcel. A slurry cut-off wall was installed along the northern boundary of the AFS Parcel to prevent potential migration of impacts from the affected property to the north onto the AFS parcel.
- A historical surface-water intake in the northwest corner of the parcel was abandoned during soil removal activities by capping the intake pipes at the River seawall and filling the wet well with flowable fill.
- Remediation objectives were achieved with the removal of source material and the elimination of soil ingestion and inhalation exposure routes for both residential and construction worker land use in accordance with the Illinois EPA SRP.

1.9.2 Division Street Upland OU

Response actions completed include the removal of MGP-impact soil, and installation of asphalt paving, concrete, and three feet of imported virgin granular material on the Western Property (Figure 3B). Details of the response action are included in RACR for the Former Division Street Station MGP (B&McD 2008). The following is a summary of the response actions completed.

Remedial action activities were conducted between September, 2003, and August, 2005. These activities were conducted in three phases and included the removal of accessible, impacted historical MGP underground structures and tar, and excavation of impacted soil to depths up to 30 feet bgs. Approximately 169,000 tons of impacted soil and 1.2 million gallons of impacted water were removed from the Western Property. Impacted soil was disposed at the Waste Management, Inc. (WMI), CID facility in Calumet City, Illinois, as nonhazardous special waste. Excavated areas were backfilled with imported unimpacted virgin granular material.

Remediation addressed a former 517,224-CF gas relief holder. The relief holder had a dome-shaped clay floor at approximately 17 feet bgs, in the center, that extended to approximately 25 feet bgs at the relief holder wall. After excavation to the bottom of the holder wall, residual impacted material located on the outside of the holder wall was re-entering the holder area. Because of the close proximity to the active railroad to the west, only the eastern holder wall was demolished. Flowable fill was placed inside the western wall and plastic sheeting was installed to immobilize the limited amount of impacted material that could not be excavated. In accordance with the requirements set forth in 35 Illinois Administrative Code (IAC) 742.90, an impractical remediation request was prepared and is included as an appendix of the Completion Report (B&McD 2008). Illinois EPA

subsequently approved of the impractical remediation, based on the fact that the limited amount of residual tar that could not be excavated was contained, was immobile, and no reasonable exposure pathways existed.

In November, 2007, surface soil excavation was conducted in limited areas of the Western Property, adjacent to the railroad, that were previously inaccessible during the 2003-2005 remediation effort. The 2007 remediation activities included removal of surface soil and reinstallation of the 3-foot soil cap over an approximately 1,000-square foot area and a 4,500-square foot area. Approximately 1,000 tons of non-hazardous special waste were removed from the Western Property and disposed at the WM CID facility in Calumet City, Illinois.

A RACR was submitted to Illinois EPA with a request for a No Further Remediation (NFR) letter. The RACR Addendum Letter addressing the additional activities was prepared in December, 2007, but was not submitted to Illinois EPA. The remedial action activities conducted in 2003-2005 and 2007 were intended to be final remedial actions under the SRP; therefore, no soil or groundwater monitoring was subsequently conducted on the Western Property. No known remediation activities have been conducted on the Boatyard Parcel or the Bar Parcel. Also, no known remediation has been conducted in the OU2 or in the River.

1.9.3 North Station Upland OU

Remedial actions within the OU have been conducted on the ComEd and Old Town Village West parcels (Figure 3C). Due to the limitations posed by the operating electrical substation on the ComEd parcel, remedial measures have been associated with the construction of additional substation infrastructure, only. Remedial action performed on the historic LaSalle-Chestnut parcel (no longer part of the North Station upland OU1) involved extensive soil excavation intended to be a final remedy. These activities are described below.

ComEd Parcel

ComEd intended to install new transformer capacitors on the northwest portion of the property where potential former MGP structures existed. Interim response actions were conducted by PGL at the request of ComEd (Barr 2001). The overall objective of the interim remedial action was to remove MGP-affected soils and historical structures from the footprint of the proposed capacitor bank location.

The interim remedial action was conducted in December, 1999, and consisted initially of placing pilot borings in an area delineated by ComEd as the site of their future capacitor bank. The borings determined the nature and extent of soil materials exhibiting MGP residuals at the location, as well as the existence of potential underground structures. The former capacitor bank foundations present at the location were removed and the delineated area was then excavated to a depth of approximately 4.5 feet bgs. Based on ComEd, the excavation depth was selected to allow for placement of suitable base materials underneath the planned capacitor bank foundations.

Most of the excavated material was gravelly clay and clayey fill, with some traces of wood, brick, concrete, and metal debris. The excavation interval of 3 to 4.5 feet bgs showed visible signs of oily coal tar-like material (free phase) and coal tar-like residuals. The coal tar-like residual material appeared to be mainly associated with a perched water interval present at the top of clayey fill (3 to 4 feet bgs). Numerous concrete foundations and piers were also removed, as well as wood and galvanized piping materials and a crushed, buried galvanized steel tank, approximately 20 feet long by 8 feet in diameter.

The excavated area formed a rectangle approximately 36 feet by 67 feet. A total soil volume of approximately 420-CY was removed during this phase of the remedial action and disposed at a Clean Harbors, Inc., facility. Subsequent characterization of these materials showed that they were not hazardous waste.

A total of 5,864 gallons of perched groundwater was disposed off-site by Clean Harbors, Inc., to facilitate excavation to the desired depth.

The excavation backfill included a base of crushed rock (Illinois Department of Transportation [IDOT] Coarse Aggregate [CA]-6) and then gravel (CA-1) to a finish grade within the excavated area of 3 feet below the original site grade. A total of 308 tons of fill materials were placed and compacted in anticipation of further site activities. A new set of capacitor banks has since been installed at the excavated location.

Air sampling was conducted during the remediation activities to assess potential migration of MGP residuals during the interim remedial action. Three air samples were analyzed for benzene, naphthalene, coal tar pitch volatiles, and phenol. The results indicated no detections for any of the analyzed compounds.

Subsequent remediation activities were conducted solely by ComEd at two additional areas, prior to substation construction work. Approximately 1,100-CY of additional soil materials were reportedly excavated. Information on these remedial activities was not reported as part of the interim response actions conducted by Barr (Barr 2001).

ComEd reported that additional soil removal has been performed since, for installation of conduits and cables at various locations on the property. Removal depths or observations during excavations were not reported.

Old Town Village West Parcel

Historic investigation activities at the Old Town Village West Parcel (Figure 3C), indicated that soils exceeded Illinois EPA Tier 1 soil remediation objectives for residential property use for PAHs, lead, and arsenic (Pioneer Engineering & Environmental Services [Pioneer] 2002). A Remediation Objectives Report and Remedial Action Plan (Pioneer 2002b) was approved by Illinois EPA that included construction of engineered barriers to address potential soil ingestion exposure and development of a Health & Safety Plan to address future construction activities in certain areas of the site.

Elimination of the soil ingestion exposure route was accomplished by removing surface soil to a depth of 1.5 feet bgs in all landscaped areas of the development, to accommodate a 1-foot thick compacted clay barrier and 6 inches of topsoil. In areas of parks, the elevation was raised by 2 feet with compacted clay and topsoil to achieve the engineered barrier requirement. Other areas of the property were covered by concrete walkways or floors/pads of the buildings. As appropriate, structurally unsuitable materials were excavated from areas of the buildings for construction purposes (Pioneer 2004, 2005). Properties formerly owned by PGL only encompassed portions of these remediation areas.

Institutional controls implemented for the site include requirements for maintaining the engineered barriers, health and safety plans (HASPs) for any future excavation, handling of future excavated soil, in accordance with applicable laws, and recording the NFR letter in the chain of title. NFR letters were issued by Illinois EPA for Site Remediation Sites 4 and 5 on January 25, 2005, and June 15, 2005.

1.10 REPORT ORGANIZATION

This RI report is organized as follows:

- Section 1: Introduction
- Section 2: Site Characteristics
- Section 3: Site Characterization Investigation Approach
- Section 4: Investigation Observations and Results
- Section 5: Fate and Transport
- Section 6: Summary
- Section 7: Conclusions
- Section 8: Preliminary Remedial Action Objectives
- References

Figures, tables, and important documents included within an appendix are provided to supplement the text of the RI report.

2 SITE CHARACTERISTICS

2.1 SITE GEOLOGY AND HYDROGEOLOGY

The information provided below incorporates data obtained during RI activities and previous SIs, including observations from soil borings, test pits, groundwater monitoring wells, and relevant publications.

2.1.1 Regional Setting

The Chicago area geology consists of unconsolidated glacial deposits of Quaternary age sediments, consisting primarily of glaciofluvial sand and gravel deposits, as well as glaciolacustrine deposits of silt and clay from ancestral Lake Chicago. These deposits overlie Silurian-age bedrock deposits. The Chicago area lies within the broad, sloping arch of Paleozoic bedrock called the Kankakee Arch on which bedrock dips gently to the east toward Lake Michigan (Willman 1971).

Surface soils in the Site consist of Wisconsin episode lake clays and silts associated with Carmi member of the Equality Formation (Lineback 1979). This unit is described as yellowish brown to brown or bluish-gray to gray clay and silt, well-bedded, soft, commonly thinly laminated and locally varved. Most deposits underlie extensive, flat, low-lying areas formerly occupied by glacial lakes; some are in small, separate lake basins; a few are in slack-water valleys tributary to major river valleys. They are commonly covered by unmapped Richland Loess, thin eolian sand, swamp deposits, or alluvium. Unconsolidated deposits in the vicinity are expected to have a thickness of approximately 50 feet.

The regional bedrock stratigraphy consists of dolomite, limestone, shale, and sandstone, and varies between 3,300 and 5,400 feet in thickness (Willman 1971). In general, the top of the bedrock sequence consists of Silurian dolomite of the Niagaran series, ranging in thickness from approximately 50 to 500 feet (Willman 1971). The dolomites and limestones of the Niagaran series contain significant fractures and solution features (B&McD 2002). Bedrock aquifers are found within Silurian, Ordovician, and Cambrian formations, which are greater than 50 feet bgs. The estimated potential yield for the aquifers ranges from 45 million gallons per day (mgd), for the deep Cambrian-Ordovician aquifers, to 75 mgd for the unconsolidated glacial drift aquifer (Suter *et al*. 1959).

The shallow groundwater in the Chicago area is limited to sand and gravel horizons in unconsolidated soil and fractured bedrock aquifers (Willman 1971). Precipitation and surface water infiltration recharge the shallow groundwater aquifers. The Site OUs are in an area designated "E" by the Illinois State Geological Survey. The "E" region consists of silty to clayey glacial till over 50 feet thick. This till has no interbedded sand and gravel deposits, and is relatively impermeable with good attenuation capacity for contaminants (Berg *et al*. 1984).

The City groundwater ordinance prohibits the installation of potable water wells within City limits. A copy of this ordinance is provided in Appendix I of the Former North Station MGP Site SSWP, Revision 1 (NRT 2012). A survey was performed to identify the presence of wells located within a 1,000-foot radius of the North Station OU1 (B&McD 2006a). Various agencies were contacted with requests for pertinent potable well information, including Illinois State Water Survey, Illinois State Geological Survey, Illinois Department of Public Health, Illinois EPA Bureau of Water, Cook County Department of Public Health, Chicago Department of Public Health, and Chicago Department of Water Management.

Well information received from the Illinois State Water and Geological Surveys indicated no potable wells are located within a 1,000-foot radius of the North Station OU1. Four private industrial/commercial wells were identified within a one half-mile radius of OU1, extending into the Cambrian-Ordovician bedrock aquifers at depths ranging from 1,240 feet bgs to 2,164 feet bgs.

2.1.2 Local Setting

During previous River investigations completed by B&McD in 2006 and 2007, sediments consisting primarily of fines (*i.e.* silt and clay), typically ranging in thickness from two feet to greater than 20 feet, throughout most of the river channel bottom within the OU2s were observed. This material generally had low plasticity and has

been observed to be black to olive gray in color. This unit also consists of varying amounts of urban trash, coal pieces, wood debris, sand, and gravel. Sediments are deposited by rivers as flow velocity changes and allow entrained material to settle along the river bottom.

Underlying the fine sediment is a brown to gray silty clay unit (Carmi member of the Equality Formation). The silty clay unit consists of very stiff clay with trace silt and sand, as well as trace amounts of subangular fine gravel. This unit was typically encountered 4.5 to 22.5 feet below mudline. This unit was formed in an historic lacustrine depositional environment.

Surficial material located outside the boundaries of the Site OU2s is not included in this discussion. Historic boring logs collected by the MWRD and B&McD describing the sediment and the underlying material of the Site are provided in Appendices A1 and A3.

2.2 SITE AND REGIONAL TOPOGRAPHY AND DRAINAGE

The upland portions of the Site are relatively flat and much of the land is improved with buildings, paving, and landscaping. The upland surfaces of the Division Street, Willow Street, and North Station OU1s are approximately 590 to 600 feet above mean sea level (NAVD88). Regional surface water flow at each upland OU is directed toward the River. The River elevation, separated by bulkhead walls from upland, is approximately 576 feet above mean sea level, and flows south to its confluence with the Main and South Branches of the Chicago River at Wolf Point, located approximately 0.8 mile downstream of the downstream end of the Site, at the Chicago Avenue Bridge. River flow is reported to be slow moving under normal conditions. Surface water runoff is primarily controlled by multiple storm sewer inlets located on the OUs that direct most of the surface water into the City combined sewer system. Precipitation not collected in storm sewers infiltrates the unpaved ground surfaces.

2.3 SITE UNDERGROUND UTILITIES

Existing underground utilities on and near the OUs are shown on Figures 6A through 6C, and are described below.

2.3.1 Willow Street OUs

Existing underground utilities on and near the Willow Street OUs are shown on Figure 6A.

A section of the MWRD TARP (*i.e*. Deep Tunnel) runs beneath OU2. The top elevation of the tunnel is approximately 360 feet above mean sea level (NAVD88). There are no TARP interceptor tunnels or access shafts within the OU. Two PGL utility tunnels cross the river adjacent to West North Avenue, located in the southern portion of the OU2.

There was a former water intake at the northwest boundary of the AFS Parcel, north of OU1. A former pump house was located in this area, as well, but has since been removed.

2.3.2 Division Street OUs

Existing underground utilities on and near the upland Division Street OU1 are shown on Figure 6B. Water, telecommunication, gas, and sewer lines are present in and around the upland OU. A decommissioned pipe terminates along the northwestern sheet pile wall. A water supply line crosses OU2 at the Division Street Bridge. A ComEd utility tunnel crosses the River adjacent to West Division Street Bridge.

2.3.3 North Station Street OUs

Existing underground utilities on and near the North Station OUs are shown on Figure 6C. Electric, water, sewer, gas, and phone lines are present under the streets surrounding the upland OU.

A number of utilities are identified within North Station OU2. A ComEd utility tunnel originating from the ComEd parcel, runs under the River in a west to east direction. Sewer and water lines cross OU2 at the Division and Halsted Street bridges. The MWRD TARP deep tunnel runs through North Station OU2 at an approximate depth

of 360 feet above mean sea level (NAVD88) with an access shaft to the deep tunnel located on the southwestern corner of the upland OU. A cable crossing is located in the northern portion of the OU2 along with a 50-inch watermain that crosses the River adjacent to West Division Street Bridge. Approximate locations of known utilities are shown on Figure 6C.

2.4 CLIMATE

Based on "Climate Information for Chicago, Illinois" (Illinois State Climatology Office 2008), the climate near Chicago is typically continental with some modification by Lake Michigan. The moderating effect of Lake Michigan is illustrated by the duration of the growing season of 170 to 175 days along the coastal area, which is the same as central Illinois. The average date of the last spring freeze is late April and the first autumn freeze occurs in mid-October along the Lake Michigan coastline. Most of the streams and lakes in the area are ice-covered from late December to late February. Flooding is most frequent during April.

Average monthly temperatures range from about 24 degrees Fahrenheit (^{0}F) in January to about 74^{0}F in July. The high and low monthly averages range by approximately ±10 ^{0}F from the monthly mean. Almost 60% of the total annual rainfall generally occurs between May and October. Almost 90% of the total annual snowfall occurs between December and March. Overall, the average annual temperature for the area is 50^{0}F and over 73 total inches of precipitation (*i.e.*, both rain and snow) is received.

Weather in the area of the Site generally consists of cold dry winters and warm humid summers. Relatively large changes in temperature, humidity, precipitation, and wind direction over short durations are common. Annual mean weather conditions at O'Hare International Airport, calculated for the period between 1981 and 2010, are presented in Table A below (Midwest Regional Climate Center 2018).

Table A. Monthly Weather Conditions at O'Hare International Airport

Month	Monthly Temperature Ranges (^{o}F)			Monthly Averages (in.)	
	High	Low	Mean	Precipitation	Snowfall
January	31.0	16.5	23.8	1.73	10.8
February	35.3	20.1	27.7	1.79	9.1
March	46.6	29.2	37.9	2.50	5.6
April	59.0	38.8	48.9	3.38	1.2
May	70.0	48.3	59.1	3.68	0.0
June	79.7	58.1	68.9	3.45	0.0
July	84.1	63.9	74.0	3.70	0.0
August	81.9	62.9	72.4	4.90	0.0
September	74.8	54.3	64.6	3.21	0.0
October	62.3	42.8	52.5	3.15	0.2
November	48.2	32.4	49.3	3.15	1.2
December	34.8	20.7	27.7	2.25	8.2
		Annual Precipitation Totals:		**36.89**	**36.3**

2.5 NORTH BRANCH RIVER CHARACTERISTICS

Based on the MWRD, the River watershed consists of approximately 141 square miles. The River is west of Willow Street OUs and east of Division Street OU1. The River ranges from approximately 95 to 225 feet wide, with water depths recorded during sediment poling in 2011 ranging from 4.5 to 18.7 feet (Table 1). The North Avenue Bridge is located at the south end of the Willow Street OU2, and south of the bridge is a turning basin. South of the turning basin, the River flows to the west around Goose Island, and the Canal flows to the east around Goose Island.

The Canal is located adjacent to and west of North Station OU1 and is approximately 100 feet wide today, with water depths in OU2 ranging from 6.9 to 13.8 feet (Table 1).

The River and Canal flow south and rejoin at the south end of Goose Island, where the River continues to flow south to its confluence with the Main and South Branches of the Chicago River at Wolf Point, located approximately 0.8 mile downstream of the downstream end of the Site, at the Chicago Avenue Bridge. From Wolf Point, the combined branches flow southeast for approximately four miles as the South Branch Chicago River, until it becomes the Chicago Sanitary and Ship Canal. Characterization of current conditions of OU2s was conducted during the RI activities and results are presented in this RI Report.

2.6 POPULATION AND LAND USE

The population of the City is approximately 2,716,450 people based on the 2017 U.S. Census Bureau's Population Estimates Program (PEP).

Following a review of the City Zoning and Land Use Map (City 2018) the Site OUs are zoned as follows and are presented in Figure 5:

- The area surrounding the Willow Street OUs is a mix of industrial and residential properties, and land use is commercial and industrial. Willow Street OU1 is located in a district zoned as a Manufacturing (M3-3) and planned development (City 2018). The manufacturing zoning allows certain recreational, commercial. and industrial uses.
- The area surrounding the Division Street OUs is a mix of industrial and residential properties. Based on the Zoning Map for Chicago (City 2018), the Western Property and Bar Parcel are zoned as Planned Manufacturing District (PMD)-2. The Boatyard Parcel is zoned as Parks and Open Space (POS)-3. Surrounding property is generally zoned as PMD or Planned Development (PD).
- The area surrounding the North Station OUs is a mix of industrial and residential properties. Based on the Zoning Map for Chicago (City 2018), the Upland OU is zoned Manufacturing (M2-3) with the exception of the Old Town Village West Parcels, which are zoned as Planned Development (PD).

The North Branch Framework Plan, adopted by the Chicago Plan Commission in May, 2017, plans to modernize the North Branch industrial corridor. The study area, which includes the three former MGP OUs, will be evaluated and re-zoned for modern land use needs. The plan is to initially replace existing PMDs with Manufacturing and Downtown Services zoning. Approximately 60 acres of publicly accessible open space will also be developed (trails, wetland parks, and passive recreational spaces). Additional information regarding land use, zoning, ordinances, *etc.*, is included in the Current and Future Land Use and Reuse Assessment (Appendix B).

2.7 CULTURAL AND NATURAL RESOURCE FEATURES

An ecological compliance assessment tool (EcoCAT) search, dated July 17, 2018, of the Natural Heritage Database maintained by the Illinois DNR, lists no state-threatened and endangered species or pristine natural areas near the OUs. The banded killifish and black-crowned night heron are listed as protected resources within the vicinity of the Site. The Historic and Architectural Resources Geographic Information System (HARGIS) database did not identify any historic or archaeological sites on the OUs (search date July 17, 2018). A National Wetland Inventory maps database search conducted July 17, 2018, did not identify any wetland areas other than the River and Canal, proper (riverine). Results from these database searches are included in Appendix A4.

3 SITE CHARACTERIZATION INVESTIGATION APPROACH

3.1 RI PLANNING

Under the AOC and SOW, a generic approach to addressing all sites listed in the AOC/SOW was developed (the multi-site approach) that includes the Multi-Site Field Sampling Plan (FSP), Revision 4 (Integrys Business Support, LLC., Inc. [IBS] 2008), the Multi-Site Quality Assurance Project Plan (QAPP), Revision 2 (IBS 2007c), and the Site-Specific HASP (IBS 2007b), Multi-Site Risk Assessment Framework (RAF) (Exponent 2007) and a Conceptual Site Model (CSM) (Exponent 2007) for executing the RI at the sites. RI field activities for Willow Street, Division Street, and North Station River OUs were performed in accordance with the USEPA-approved multi-site documents prepared specifically for the PGL-owned former MGP sites in the SAS program.

Prior to beginning of the RI activities, SSWPs were developed (Willow Street SSWP, Revision 2 [NRT 2011b], Division Street SSWP, Revision 1 [B&McD 2009b], and North Station SSWP, Revision 0 [NRT 2011] along with Revision 1 [NRT 2012]) to identify data needed to characterize the OUs and to meet the Data Quality Objectives (DQOs) in order to evaluate potential human health and ecological risks. Site-specific modifications were made to the Multi-Site FSP and CSM and they were reissued with the SSWPs for the OUs. The SSWPs were developed based on current site conditions and available historical data. As the data were collected and evaluated, additional investigation locations were identified as part of Step II sampling activities.

3.2 PRELIMINARY CONCEPTUAL SITE MODEL

The CSM is a representation of the relationship between the impacted media and potential receptors. The model considers the chemical and physical characteristics to evaluate the potential or actual migration and exposure pathways. A CSM was developed as a generalized model in the Multi-site CSM (IBS 2007). The generalized CSM was revised in the SSWPs, based on known site operational history, past SIs, and current site conditions. Potentially affected media, pathways, and/or receptors have been identified in this preliminary site-specific CSM.

The preliminary CSM for Willow Street, Division Street, and North Station are essentially the same and are presented in the respective SSWPs. These models were used to identify investigational gaps addressed in the RI. Data from this RI were used to further refine the CSM and will ultimately be used to support the FS and develop appropriate remedial action. Refinements to the preliminary CSM included confirming affected media, potential receptors, and complete exposure pathways; and identifying the need for further evaluation, if any. The updated CSM is discussed in Section 5.3 and includes revised construction worker and recreation receptors.

3.3 SUMMARY OF SAMPLING ACTIVITIES AND TIMELINE

This section discusses sediment and surface water sampling activities that were completed in the Site, which include investigation activities conducted within the Willow Street OU2, Division Street OU2, and North Station OU2. RI in the upstream ambient reach is also documented here for reference. The field investigations included ambient, Step I, and Step II sediment and surface water sampling which took place from March, 2011, through December, 2013. They are summarized in Table B below.

Table B. Sampling Activities and Timeline

Investigation Area	Investigation Activity	Sampling Locations	Date(s) Completed
Ambient Area	Sediment Sampling	30	March 2011
	Surface Water Sampling	4[a]	December 2011
	Additional Surface Water Sampling	4[a]	November 2012
Willow Street OU2	Step I Surface Water Sampling	4	December 2011
	Step I Sediment Poling, Sediment Sampling	26	January - February 2012
	Step II Surface Water Sampling	4	November 2012
	Step II Sediment Sampling	31	August 2013 - December 2013
Division Street OU2	Step I Surface Water Sampling	4	December 2011
	Sediment Poling, Step I Sediment Sampling	44	January - February 2012
	Step II Surface Water Sampling	4	November 2012
	Step II Sediment Sampling	50	August 2013 - December 2013
North Station OU2	Step I Surface Water Sampling, Sediment Poling	4	November 2012
	Step I Sediment Sampling	33	August 2013 - December 2013

[a]Sample locations used for OU2 ambient sampling.

Sediment and surface water sampling locations in the ambient reach are depicted in Figure 7, and locations in the OU2s are depicted in Figures 8A through 8C. See Table 2 for a summary of sampling location data.

Characterization activities were performed in accordance with the USEPA-approved multi-site documents, including the Multi-Site QAPP, Revision 2 (IBS 2007c), Multi-Site RAF (Exponent 2007) and FSP, Revision 4 (IBS 2008). OU-specific information based on these documents are discussed in the SSWP, Revision 2 (NRT 2011b), used for Step I and Step II work at the Willow Street OUs, the SSWP, Revision 1 (B&McD 2009b), used for Step I and Step II work at Division Street OUs, and the SSWP, Revision 1 (NRT 2012), used for Step I work at the North Station OUs.

3.4 MOBILIZATION

Field mobilization activities were completed in accordance with USEPA-approved Standard Operating Procedure (SOP) SAS-05-01 and Section 3 of the Multi-Site FSP. These activities included the following:

- Notifying and locating utilities through DIGGER–Chicago Digger Hotline
- Establishing clear communication from the field to office personnel, PGL, and the USEPA
- Obtaining applicable permits for site activities from the Chicago Department of Transportation, Chicago Office of Underground Coordination (OUC), USACE, Illinois EPA, and Illinois DNR for sediment and surface water sampling activities within the River and Canal

Work near buried or overhead utilities only proceeded after utilities and reasonable setbacks were field-verified and safety standards for operations were maintained. Daily planning occurred, as described in the Multi-Site FSP and the Site-Specific HASP, including, but not limited to, the following:

- Holding daily safety tailgate meetings
- Tracking daily progress
- Identifying and resolving problems
- Communicating with office personnel, PGL, and the USEPA/Illinois EPA, as appropriate, to ensure decision points and objectives for the work were fulfilled

A field log book was maintained, following the procedure outlined in USEPA-approved SOP SAS-01-01 from the Multi-Site FSP.

3.5 SITE SURVEYING AND BASE MAPS

A hydrographic survey (single beam) was performed in the Willow Street OU2 and Division Street OU2 by American Survey and Engineering (ASE) between December 11 and December 16, 2011. The hydrographic survey was supplemented by a side scan sonar survey to provide additional accuracy in locations with shallow water depth and images of the sediment surface. The survey vessel conducted transects parallel to the River alignment, at approximately eight-foot offsets, to provide a complete top of sediment profile of each OU2. Horizontal survey points were collected in North American 1983 Datum (NAD83) Illinois East state plane coordinates and vertical survey points were collected in NAVD88. The top of sediment elevation contours generated from this bathymetric survey are shown on Figure 9A (Willow Street) and 9B (Division Street).

A bathymetric survey was performed in North Station OU2 by ASE on January 30, 2013. The bathymetric survey of river bottom elevation was completed using a high-resolution multi-beam echosounder (200/400 kHz), which was supplemented by a side scan sonar survey (400/900 kHz) to provide additional accuracy in locations with shallow water depth and images of the sediment surface (Appendix C1). The survey vessel conducted transects parallel to the river alignment, at approximately eight-foot offsets, to provide a complete top of sediment profile of the OU2. Horizontal survey points were collected in NAD83 Illinois East state plane coordinates and vertical survey points were collected in NAVD88. The top of sediment elevation contours generated from this bathymetric survey are shown on Figure 9C.

3.6 SITE-SPECIFIC COPCS

The site-specific COPCs vary by parcel and are presented in detail in the following documents: SSWP, Revision 2 (NRT 2011b), used for Step I and Step II work at the Willow Street OU2; SSWP, Revision 1 (B&McD 2009b), used for Step I and Step II work at Division Street OU2; and SSWP, Revision 1 (NRT 2012), used for Step I work at North Station OU2. No deviations from the site-specific COPC list occurred during the RI. Table C below summarizes the COPCs analyzed for each media within each OU2.

Table C. SSWP COPCs

OU2	Media	COPCs
Willow Street	Sediment*	Petroleum volatile organic compounds (PVOCs), PAHs, PCBs, phenols, total cyanide, aluminum, antimony, arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, selenium, silver, vanadium, and zinc
	Surface Water	PVOCs, PAHs, PCBs, phenols, available cyanide, aluminum, antimony, arsenic, barium, cadmium, chromium, copper, iron, lead, magnesium, manganese, mercury, nickel, selenium, silver, vanadium, and zinc
Division Street	Sediment*	PVOCs, PAHs, phenols, total cyanide, aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, copper, iron, lead, manganese, nickel, selenium, silver, vanadium, and zinc
	Surface Water	PVOCs, PAHs, phenols, available cyanide, aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, copper, iron, lead, magnesium, manganese, mercury, nickel, selenium, silver, vanadium, and zinc
North Station	Sediment*	PVOCs, PAHs, phenols, total cyanide, aluminum, antimony, arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, selenium, silver, vanadium, and zinc
	Surface Water	PVOCs, PAHs, phenols, available cyanide, aluminum, antimony, arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, selenium, silver, vanadium, and zinc

* Total organic carbon (TOC) and black carbon were also analyzed in select samples for site profiling.

3.7 SEDIMENT SAMPLING AND INVESTIGATION

3.7.1 Assessment Objectives

The purpose of OU2 sampling was to characterize the magnitude and extent of surface water and sediment potentially affected with MGP residuals and to provide data to support human and ecological risk evaluations. The ambient investigation was completed to evaluate media outside of the Site OUs and outside the influence of the MGPs. Specific assessment objectives included the following:

- Establish a statistically sound assessment of ambient conditions not influenced by MGP residuals, through an evaluation of upstream sediment quality and toxicity.
- Determine the River and Canal bathymetry in the OU2s.
- Determine sediment thicknesses in the OU2s.
- Establish a statistically sound assessment of the overall OU2s, compare OU2 conditions to ambient conditions, characterize the presence of potential MGP residuals in OU2s, and, if necessary, evaluate toxicity adjacent to and downstream of the OU2s.
- Determine the nature and extent of MGP-derived impacts to surface water and sediment.
- Assess the source and origin of PAHs in the sediment profile, through use of forensic chemistry methods on sediment samples, as needed.

Sampling and evaluation activities conducted to meet objectives are described in the following sections.

3.7.2 Ambient Reach

In 2011, an ambient sediment and surface water investigation was performed upstream of the North Branch MGP Site, to characterize ambient sediment quality in the River. The ambient sediment sampling approach was included as Appendix C of the North Station SSWP, Revision 0 (NRT 2011). Detailed procedures, results, and analysis of the ambient sediment investigation data, including a discussion of ambient sediment toxicity, were provided in the Step I Data Evaluation for North Branch Sediment Sampling, Revision 2 (NRT 2013), which is included in Appendix E1. The ambient sediment investigation was performed to:

1. Characterize ambient concentrations of potentially MGP-related COPCs in the River unrelated to influences of Site activities.
2. Evaluate if sediment toxicity would be a useful tool for characterizing ecological risk zones at the downstream North Branch MGP Site.

A brief summary of ambient sediment sampling is included below.

3.7.2.1 Sediment Sampling Locations

The former MGPs are located along a heavily industrialized section of the River. The urban setting and historic releases to the OU2s from a variety of industrial sources has resulted in impacts to river surface water and sediment quality that are not derived from former MGP operations. To help determine which sediment characteristics in the OU2s are potential results of former MGP operations, ambient sediment sampling was performed upstream of the OU2s, to characterize sediments outside the influence of the former North Branch MGPs.

Ambient sediment conditions were defined within an approximate 1.3-mile segment of the River, upstream from the Site (Figure 7). This segment is not affected by the former PGL MGP sites, but has been influenced by the general urban Chicago environment and best represents the ambient conditions near the Site.

In March, 2011, sediment was collected at 20 ambient sampling locations that were not known to be influenced by obvious and current or historic PAH sources. In addition, sediment was collected at nine ambient sampling locations that were known to have potential influence from non-MGP PAH sources (source sample locations). These source area locations were selected based on a field reconnaissance of the ambient reach of the River that was performed on July 7, 2010, to identify and map all visible outfalls and potential PAH source areas, current and historical, in the ambient segment, as described in technical memorandum "Supplement to Characterization of Ambient Conditions in the Chicago River Upstream of the North Branch MGP Site" (Exponent 2009). Source

sediment sampling locations were documented with a differential global positioning system (DGPS) unit during the field reconnaissance. The purpose of these source samples is to define the chemical fingerprints of suspected non-MGP PAH sources affecting the ambient segment of the River, as well as the relationship between these sources and overall ambient conditions. It was assumed that storm sewer outfalls are discharge points where contaminants from non-MGP sources and general urban stormwater runoff may have entered the River. Therefore, source area surface sediment samples were collected where storm sewer outfalls are located that correspond to a potential PAH source, to characterize potential contamination. The ambient and source sediment sampling locations investigated within the ambient study area in March, 2011, are shown on Figure 7.

A total of 59 discrete ambient sediment samples were collected from the 20 ambient sampling locations. At each of the 20 ambient sampling locations, a surface sediment sample was attempted, and at 19 sampling locations, a surface sample (0–0.5 feet below mudline) was recovered. At sample location ACR-11, a surface sample could not be collected because of rocky conditions. At five of the 20 ambient sediment sampling locations (ACR-1, ACR-3, ACR-11, ACR-14, and ACR-20), 30 vertical profile sediment samples were collected. Each sediment core collected at a vertical profile location was subdivided into discrete 1-foot depth intervals for sampling. The end depth of the vertical profile was limited to the thickness of the soft sediment layer at the sampling location. Samples were submitted for chemical analysis. A subgroup of the surface ambient sediment samples (10 of 19 collected) was also submitted for sediment toxicity testing.

Nine source area surface sediment samples (SCR1 through SCR5, and SCR8 through SCR11) were also collected at the sediment surface (0–0.5 feet below mudline). Source area samples were submitted for chemical analysis, but not toxicity testing. Sediment boring logs from the ambient reach are provided in Appendix D3.

3.7.2.2 Sediment Sampling Methods

From March 2, 2011, to March 9, 2011, surface sediment at the selected ambient and source sediment sampling locations was collected by the field team using a jon boat equipped with sediment sampling equipment and spuds to maintain position during the sampling process. Pre-selected sampling locations were located in the field using a DGPS unit.

Immediately prior to sample collection, water depth and sediment poling depth (used to estimate soft sediment thicknesses) were measured and recorded on the Sample Collection and Processing Log (provided in Appendix D1). The actual location of the sample was also recorded with the DGPS unit. Surface sediment samples were collected using a push-corer, with repeated deployments at the same location for samples that required additional volume (*e.g.*, toxicity sampling locations). Sample materials were described and logged on Sample Collection and Processing Log per SOP SAS-07-01. A 10.6 eV photoionization detector (PID) was used to detect the presence of volatiles within the sample material and the results were recorded on the Sample Collection and Processing Log. Following surface sediment sampling, water elevation data was gathered from both the River at Albany Avenue, Chicago, IL *(i.e.*, USGS Stream Site 05536105) and the River at Grand Avenue, Chicago, IL (*i.e.*, USGS Stream Site 05536118) gaging stations.

Ambient sediment sample locations that required vertical profile sediment samples (five locations) were collected using a barge-mounted hollow stem auger (HAS) drill rig operated by Geo Services, Inc., using 2- and 3-inch diameter split spoons. The vertical profile borings were sampled continuously, using a split-spoon sampler, until they encountered native clay. The maximum depth of the vertical profile borings was 11.5 feet. Samples were visually characterized, logged, and sub-sampled in general accordance with Section 4 of the Multi-Site FSP. Upon completion of sediment borings, non-dedicated sampling equipment was decontaminated, as described in Section 8 of the Multi-Site FSP, Revision 4 (IBS 2008). All drill cuttings and water used during drilling were containerized in 55-gallon drums and treated as investigation-derived waste (IDW), as described in Section 3.7.3.9 of this report and in Section 9 of the Multi-Site FSP, Revision 4 (IBS 2008).

The site-specific COPCs identified in the "Characterization of Ambient Conditions in the Chicago River Upstream from the North Branch MGP Site" (Revision 1) (Exponent 2009) and the technical memorandum, "Supplement to Characterization of Ambient Conditions in the Chicago River Upstream of the North Branch MGP Site" (Exponent 2010) are listed in Table D below. Details on analytes are provided in Table B-1 of Enclosure B (Appendix E1) and analytical laboratory reports are included in Appendix E5.

Table D. Ambient Analysis

Investigation Area	Investigation Activity	Analysis
Ambient Area	Surface (0-0.5 feet)	PAHs (including alkylated PAHs), PVOCs, phenols, inorganics (arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, selenium, silver, vanadium, zinc) and cyanide
	Subsurface (>0.5 feet)	PAHs (including alkylated PAHs) and inorganics (arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, selenium, silver, vanadium and zinc)

The ambient surface sediment sample data were used to calculate the 95 percent (%) upper tolerance limits (UTL) on the 95th percentile for the ambient data set (Total PAHs [TPAHs] and inorganics). For the purposes of this report, TPAHs will refer to the sum total of the following 13 PAHs: acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, fluoranthene, fluorene, naphthalene, phenanthrene, and pyrene.

The UTLs are concentration limits above which the individual sample result collected at a downstream former MGP site is more likely to be due to MGP sources (*e.g.,* MGP residuals) than ambient conditions, and so would represent a sample location where MGP-related effects are considered potentially present. Conversely, if the concentration of an analyte is below the UTL at an investigative location, it is more likely to represent ambient conditions, rather than indicate an influence from the former MGP site. Detailed description of the statistical analysis methods used to determine the UTLs are included in Appendix E1.

For quality assurance and quality control (QA/QC) purposes, a blind duplicate sample and a matrix spike/matrix spike duplicate (MS/MSD) sample were submitted to each laboratory at a rate of approximately one in 20 samples. Equipment blanks were collected at the end of each day during the vertical profile sampling, by running deionized water over non-dedicated equipment used during the sampling (*i.e.*, split-spoon sampler) and analyzing the water for PAHs (non-alkylated PAHs), PVOCs, phenols, metals, and available cyanide. Dedicated equipment was used for locations where only surface sediment was collected with a push-corer; therefore, equipment blanks were not necessary.

Samples were submitted to Pace Analytical and Test America laboratories for analysis of the site-specific COPCs.

3.7.2.3 Sediment Toxicity Sampling and Analysis

Ten ambient surface sediment samples were tested using the 28-day chronic sediment toxicity testing protocol that utilizes *Hyalella azteca* as the test species. Samples were collected from surface sediment (0 to 0.5 feet below mudline) at ambient sampling locations ACR-1, ACR-3, ACR-5, ACR-7, ACR-9, ACR-15, ACR-16, ACR-17, ACR-18, and ACR-21, as shown on Figure 7. Toxicity samples were tested by Coastal Bioanalysts, Inc. The full sediment toxicity laboratory report from Coastal Bioanalysts, Inc., is provided in Appendix E1. The sediment toxicity test measures percent survival and growth at the termination of the test. Growth is measured both as the mean weight of the test organisms and the mean length of the test organisms. Generally, the weight index is used to address whether there are effects on growth to the test species, so the weight index was focused upon for this evaluation. In addition to the 10 ambient surface sediment samples tested, a laboratory control sediment sample was evaluated for quality control purposes as part of the assay.

3.7.2.4 Surface Water Sampling

Surface water sampling within the ambient reach of the Site is described in Section 3.7.8.

3.7.3 OU2 Investigations

Following the ambient sediment investigation, three OU2 investigation activities were conducted between December, 2011, and December, 2013, to characterize existing conditions in the constituent OU2s of the Site. Sediment sampling objectives included the following:

- Determine OU2 morphology and bathymetry
- Determine sediment thicknesses in OU2s
- Determine the nature and extent of MGP effects on surface water and sediment
- Assess the source and origin of PAHs in the sediment profile, through use of forensic chemistry methods on sediment samples, as needed

The specific sediment characterization and sampling activities are described in the following sections.

3.7.3.1 Morphology and Bathymetry

ASE was contracted to provide hydrographic survey and sidescan sonar of the three OU2s within the Site.

For the Willow Street OU2 (Figure 9A), the survey area covered the width of the River from the North Avenue Bridge to a point just downstream of the sediment sampling area of the OU2 (total distance of approximately 1,400 feet). Six longitudinal transects and 13 transverse transects (spaced approximately 100 feet apart) were used for the surveys. Surveys were completed by ASE using their survey vessel on December 6 through 11, 2011.

For the Division Street OU2 (Figure 9B), the survey area covered the width of the River upstream of the Division Street Bridge to a point approximately 200 feet downstream of the south edge of the sediment sampling area of the OU2 (total distance of approximately 2,400 feet). Surveys were completed by ASE using their survey vessel on December 6 through 11, 2011.

For the North Station OU2 (Figure 9C), the survey area covered the width of the Canal from the Division Street Bridge to a point approximately 200 feet downstream of the south edge of the sediment sampling area of the OU2 (total distance of approximately 1,800 feet). Surveys were completed by ASE using their survey vessel from January 30 to 31, 2013.

A description of ASE equipment, methods, and QA/QC procedures is provided in Appendix C1. The bathymetry and sidescan sonar imagery are provided in Appendix C2 and Appendix C3, respectively, and the resulting sediment surface contours are presented on Figures 9A through 9C.

The River at the Site has a generally north-south orientation and water flow in the River is directed from north to south. A USGS stream gauging station (#05536105) is located on the River at Albany Avenue in West River Park. This gauging station is located just upstream of the River's confluence with the North Shore Channel, approximately five miles upstream of Willow OU2s. Stream gauging data are available for this location; however, the distance from the OU2s and input from the North Shore Channel and other sewer outfalls likely limit the value of the information with respect to flow past the OU.

Surface water velocity was measured during surface water sampling in the OU2s in December, 2011, and November, 2012.

3.7.3.2 Preliminary Sediment Thickness Assessment

Preliminary sediment thickness data was collected during the Step I investigation to identify locations of sediment accumulation within the River. The presence and physical characteristics of soft sediment and the relative sediment thickness in the OU2s was assessed by poling and push-coring, per the SSWP, Revision 2 (NRT 2011b), for the Willow Street OU2, the SSWP, Revision 1 (B&McD 2009b), for the Division Street OU2, and the SSWP, Revision 1 (NRT 2012), for the North Station OU2. Sampling locations were recorded using a DGPS unit with sub-foot accuracy, in accordance with the methods described in USEPA-approved SOP SAS-03-03 and Section 7 of the Multi-Site FSP, Revision 4 (IBS 2008).

Poling was conducted by pushing a rod into the sediment with both a "soft" and a "hard" push, in accordance with SOP SAS-07-01. Depth of penetration on both pushes was recorded, along with any observations of sheen or ebullition, or other field observations. Push coring was completed using a 2 ¾-inch outer diameter Lexan tube and push-coring device. Push cores were advanced approximately 3.5 feet below mudline and thickness of sediment recovered in tube was recorded, along with sediment type.

Details of the sampling events are provided below for each respective OU2.

Willow Street OU2 Preliminary Sediment Thickness Assessment

In the *Draft River Sediment Investigation Summary* (B&McD 2006b), 38 cores were collected in July, 2006, that indicated soft organic silt dominated the surface sediments in the Willow Street OU2. Sediment thickness was reported to range from 5.5 to 13.5 feet based on core advancement. The silt was underlain by slightly plastic, stiff clay that appeared to be native.

During Step I investigation at the Willow Street OU2 from February 3 through 13, 2012, poling and push-coring were conducted at 24 of 26 proposed sampling locations (PCA-1WHS to PCA-24WHS, where PCA stands for "Physical Characterization Assessment;" see Figure 8A). Sediment thicknesses based on poling results indicate a maximum thickness of very soft sediments of 3.0 feet and an average of 1.1 feet; and an estimated maximum thickness of total sediment of 7.5 feet and an average of 3.7 feet. Sediment recovered within the push cores was generally silt (dark gray, light gray, black, or brown), with some sand and gravel, and some debris/woody debris. Sheen was encountered in the core during push-coring at one location (PCA-1WHS), and slight or faint sheen was encountered during push-coring at four locations (PCA-8WHS, PCA-20WHS, PCA-21WHS, and PCA-22WHS). Poling and push-coring sample collection forms are located in Appendix D2 and sheen observations can be seen on Figure 13A.

Division Street OU2 Preliminary Sediment Thickness Assessment

During the Step I investigation at the Division Street OU2 between December 15 and 16, 2011, preliminary sediment thickness data was collected at 40 of 44 proposed locations (DIV-PCA01 to DIV-PCA40; see Figure 8B [in this RI Report, locations are presented as STA-1DDS to STA-40DDS, to be consistent with presenting analytical data]). The thickness of soft sediment observed during this poling assessment ranged from zero (refusal) to 7.2 feet, with an average thickness of 4.4 feet. Faintly visible sheen developed on the water surface at 10 of the 40 poling locations. Poling and push-coring sample collection forms are located in Appendix D2 and sheen observations can be seen on Figure 13B.

North Station OU2 Preliminary Sediment Thickness Assessment

During Step I investigation at the North Station OU2 from November 14 to 15, 2012, preliminary sediment thickness data was collected at 33 proposed sampling locations (PCA-1NOS to PCA-33NOS; see Figure 8C). Sediment thicknesses based on poling results indicate a maximum thickness of very soft sediments of 3.1 feet and an average of 2.1 feet; and a maximum thickness of total sediment of 9 feet and an average of 5.8 feet. Sediment recovered within the push cores was generally dark brown silt, some sand, and some debris/woody debris. Sheen was encountered during push coring at nine locations. Locations where sheen was encountered are considered more side-channel than central. Poling and push-coring sample collection forms are located in Appendix D2 and sheen observations can be seen on Figure 13C.

3.7.3.3 Water Levels

River water levels were monitored with a pressure transducer and datalogger affixed to a "dolphin" (a man-made marine structure extending above the water level) near the Division Street Bridge from December 16, 2011, to April 24, 2012, for the Willow Street OU2 investigation, and from October 29, 2012, to February 28, 2013, for the Division and North Station OU2 investigations. Water levels were recorded every 15 minutes. Results of water level measurements are located in Appendix C4. This data may be used in the FS to assess river flow.

3.7.3.4 Sediment Sampling Locations and Drilling

OU2 sediment sampling was performed during two distinct sampling events. The primary goal of the initial event (Step I) was to advance evenly-spaced borings throughout the River, to identify locations requiring further investigation in the subsequent sampling event (Step II), if necessary. Step I and Step II sampling events were performed during the following periods:

- Willow Street OU2 Step I: December 2011 through February 2012
- Willow Street OU2 Step II: August through December 2013

- Division Street OU2 Step I: December 2011 through February 2012
- Division Street OU2 Step II: August 2013 through December 2013
- North Station OU2 Step I: August 2013 through December 2013

In total, 184 locations were drilled and sampled adjacent to, upstream. and downstream of the upland OU boundaries in OU2s across the Site (57 Willow Street locations, 94 Division Street locations. and 33 North Station locations; see Table B in Section 3.3). In addition, 13 samples collected during the 2006 Willow Street B&McD sediment investigation, discussed in Section 1.7.1, are evaluated as part of this RI Report. Six Division Street samples collected during the 2007 sediment investigation were analyzed for fingerprinting (2007 B&McD). Details for sampling locations in each respective OU2 are provided below.

Willow Street OU2 Sediment Sampling Locations

The Willow Street OU2 was divided into 10 segments that spanned the width of the River, and each segment was split in half at the River centerline. One spatially unbiased boring was advanced within each half-segment (PCA-1WHS to PCA-6WHS, PCA-8WHS to PCA-9WHS, PCA-11WHS to PCA-12WHS, PCA-14WHS to PCA-17WHS, and PCA-19WHS to PCA-24WHS). Four biased borings were advanced along the upland General Iron and AFS Parcels (PCA-7WHS, PCA-10WHS, PCA-13WHS and PCA-18WHS) and two additional locations (PCA-25WHS and PCA26WHS) were added at the downstream end of the sampling area during field operations, to further define the downstream extent of effects potentially related to the former MGP. In addition to the 26 sampling locations drilled and sampled during Step I, 31 more locations were drilled and sampled during Step II. Step II sampling locations were biased locations and were chosen to address data gaps and to better define the extent of DNAPL or elevated concentrations of PAHs (PCA-27WHS to PCA-44WHS). The total sampling area is comprised of the width of the River over a total distance of approximately 1,500 feet upstream of the West North Avenue Bridge, to approximately 700 feet downstream of the upland OU (Figure 8A).

Sediment borings were advanced to the maximum permitted drilling depth, or a minimum of 2 feet, into native material (lean clay) exhibiting no MGP effects. Geotechnical borings were advanced as deep as possible to the permitted drilling depth, in an attempt to identify the depth of bedrock. As a result, geotechnical borings were advanced to a minimum of 38.5 feet and a maximum of 50 feet below the mudline. Borings advanced greater than 2 feet into native material were at locations where either affected material was observed in the first 2 feet of native material, or deeper drilling was conducted to collect additional geotechnical data. During Step I sampling, no borings were advanced greater than 16.5 feet below mudline, the depth permitted for this work by the nationwide permit (USACE, Illinois EPA and Illinois DNR), and the City's OUC. During Step II sampling, borings were advanced to the maximum permitted depth of 50 feet below mudline. Sediment boring logs for the Willow Street OU2 are located in Appendix D4.

Division Street OU2 Sediment Sampling Locations

The Division Street OU2 was divided into 20 segments that spanned the width of the River, and each segment was split in half at the River centerline. One spatially unbiased boring was advanced within each half-segment (STA-1DSS to STA-40DSS). In addition to the 40 sampling locations identified in this manner, four locations (STA-41DSS to STA-44DSS) were completed at the downstream end of the sampling area to further define the downstream extent of potential effects related to the former MGP. In addition to the 44 sampling locations drilled and sampled during Step I, 50 more locations were drilled and sampled during Step II. Step II sampling locations were biased locations and were chosen to address data gaps and to better define the extent of DNAPL or elevated concentrations of PAHs. The total sampling area is the width of the River over a total distance of approximately 2,250 feet, stretching from about 300 feet upstream of the Division Street Bridge to approximately 800 feet downstream of the south edge of the upland OU (Figure 8B). Step I sediment borings were advanced up to 2 feet into the native clay, or to a maximum depth of 16.5 feet below mudline, the depth permitted for this work by the nationwide permit (U.S. Army Corps of Engineers, Illinois EPA, and Illinois DNR), and the City's OUC. During Step II sampling, a maximum boring depth of 43.5 feet below the mudline was reported. Division Street OU2 Sediment Boring logs are included in Appendix D4.

North Station OU2 Sediment Sampling Locations

The North Station OU2 was divided into 15 segments that spanned the width of the River, and each segment was split in half at the River centerline. One spatially unbiased boring was advanced within each half-segment (PCA-1NOS to PCA-30NOS). In addition to the 30 sampling locations identified in this manner, USEPA recommended placement of an additional three biased boring locations immediately adjacent to the upland OU (PCA-31NOS to PCA-33NOS), near locations where current and former discharge sewers and pipes were located. The total sampling area is the width of the Canal over a total distance of approximately 1,400 feet from about 450 feet upstream of the Halsted Street Bridge to approximately 225 feet downstream of the south edge of the upland OU (Figure 8C).

Thirty-three sediment boring locations were drilled and sampled at the OU2. Sediment borings were advanced to a minimum of 1.8 feet into native silty clay and a maximum depth of 12.8 feet into native silty clay. Borings advanced greater than 1.8 feet into native material were at locations where affected material was observed in the first 1.8 feet of native material, or adjacent to the shoreline where samples were desired from below the elevation of known upland residuals. No borings were advanced greater than 50 feet below mudline, the depth permitted for this work by the nationwide permit (U.S. Army Corps of Engineers, Illinois EPA, and Illinois DNR), and the Chicago OUC. North Station OU2 Sediment Boring logs are included in Appendix D4.

3.7.3.5 Sediment Sampling and Chemical Analysis

Using a DGPS unit, pre-determined sediment sampling locations were located by the field team using a barge-mounted HSA drill rig operated by Strata Earth Services, LLC, equipped with spuds to maintain position during the sampling process, and in accordance with USEPA-approved SOP SAS-07-03 and Section 4 of the Multi-Site FSP, Revision 4 (IBS 2008). Once the spuds were lowered into the sediment, the actual location of the boring was also recorded with the DGPS unit with sub-meter accuracy, in accordance with the methods described in USEPA-approved SOP SAS-03-03 and Section 7 of the Multi-Site FSP, Revision 4. Throughout the sediment sampling activities, the surface water elevation was recorded twice a day (once in the morning and once in the afternoon) at a nearby benchmark location (BM-205, elevation 584.05 feet above mean sea level [NAVD88]) as a reference for converting water depth measurements to elevations of top of sediment.

Once anchored at a sampling location, surface material up to 3.5 feet below mudline was collected using a push core sampling device. Following surface sediment sampling, the deeper sediment was logged and sampled continuously until the end of the boring, using the HSA and 2- and 3-inch diameter split spoons. Samples were visually characterized, logged, and sub-sampled, in general accordance with SOP SAS-05-02 of the Multi-Site FSP. A 10.6 eV PID was used to detect the presence of volatiles in the work area and within the sample material, and was recorded on the field forms. In general, sediment consisted of silt with varying amounts of clay, coal pieces, wood debris, sand, and gravel overlaying gray lean clay with trace sand and gravel. A summary of sediment field observations, such as depth of clay and location and depth of non-aqueous phase liquid (NAPL), and analytical results, are included in Section 4.4 and presented on Figures 13A through 13C.

All sediment borings were abandoned with grout to avoid creating a preferential pathway through soft sediment to native material.

For each boring location, a surface sediment sample (0 to 0.5 feet below mudline) was submitted for analysis. Material collected at depths greater than 0.5 feet below mudline was subdivided into discrete 1-foot depth intervals for sampling. Sample material from each discrete interval was homogenized in dedicated disposable plastic bags and sent to laboratories for analysis or archived. Generally, four to seven samples were selected from each core and submitted to the labs for immediate analysis, based on sampling and analysis schemes presented in the SSWP, Revision 2 (NRT 2011b), for the Willow Street OU2, the SSWP, Revision 1 (B&McD 2009b), for the Division Street OU2, and the SSWP, Revision 1 (NRT 2012), for the North Station OU2. Samples that were not immediately analyzed were frozen and shipped to the labs and archived at -20 degrees Celsius (°C) for later testing, as needed. Samples were processed and prepared for shipment to the selected laboratories, in accordance with Section 5 of the Multi-Site FSP, at a nearby sample processing station.

After both Step I and Step II sampling events, sets of sediment samples were retrieved from archive at the laboratory and analyzed for PAHs based on their location relative to potential MGP residuals identified in

previously analyzed sediments. Indicators of the potential presence of MGP residuals were the presence of NAPL or oil-coated/oil-wetted sediment, and/or concentrations of TPAHs exceeding the UTL (discussed below). Archive samples were selected for analysis based on the following criteria:

- Within the same core, samples were selected from intervals directly above and below an interval found to contain potential residuals.
- In cores adjacent to a core where sampling results indicated the potential presence of MGP residuals, sample intervals at the same elevation, and directly above and below the elevation of potential residuals were selected.

The samples submitted from archive, for analysis of PAHs after Step I sampling completed between January and February, 2012, and Step II sampling completed between August and December, 2013, are provided in Table 3. The results presented in this RI report include both the samples collected and analyzed during drilling operations and the samples retrieved from archive for analysis prior to April, 2014.

A total of 1,271 investigative samples were analyzed for the site-specific COPCs per the SSWP, Revision 2 (NRT 2011b), for the Willow Street OU2, the SSWP, Revision 1 (B&McD 2009b), for the Division Street OU2, and the SSWP, Revision 1 (NRT 2012), for the North Station OU2. All surface samples (0 to 0.5 feet below mudline) were submitted for analysis. They were analyzed for expanded list of PAHs (including alkylated PAHs), phenols, PVOCs, metals, mercury, total cyanide, percent solids, TOC, and black carbon. An additional 64 samples from archive were analyzed for PAHs only. All samples from 1.5 to 2.5 feet below mudline were also submitted for analysis. They were analyzed for the standard list of PAHs (established in the RAF, Exponent. 2007), phenols, PVOCs, metals, mercury, total cyanide, percent solids, and TOC. In addition, approximately 10% of these samples were analyzed for the expanded list of PAHs and black carbon. Initially, up to four more samples were submitted from each core from depths greater than 2.5 feet below mudline. These samples were analyzed for the standard list of PAHs, phenols, PVOCs, metals, mercury, cyanide, percent solids, and TOC. In addition, approximately 10% of these samples were analyzed for expanded list PAHs and black carbon. OU specific COPCs included PCBs at Willow Street OU2 (NRT 2011b) and beryllium at Division Street OU2 (B&McD 2009b). The selection of samples at depth that were analyzed was based on the lateral and vertical proximity of the sample interval to previously observed MGP impacts. All sediment samples analyzed for PAHs, PCBs, phenols, metals, PVOCs, and percent solids were analyzed by Pace Analytical. All sediment samples analyzed for total cyanide, TOC, and black carbon were analyzed by Test America.

For QA/QC purposes, blind duplicate samples and MS/MSD samples were submitted to each laboratory at a rate of approximately one in 20 samples. Equipment blanks were collected at the end of each day by running deionized water over non-dedicated equipment used during the sampling (*i.e.,* split-spoon sampler) and analyzing the water for PAHs, PVOCs, phenols, total metals, and total cyanide.

3.7.3.6 Sediment Geotechnical Analysis

During sampling for chemical parameters, composite and grab samples were also collected for geotechnical parameters, as proposed in the SSWP, Revision 2 (NRT 2011b), for the Willow Street OU2, the SSWP, Revision 1 (B&McD 2009b), for the Division Street OU2, and the SSWP, Revision 1 (NRT 2012), for the North Station OU2. From each boring retrieved, an aliquot of sediment from each stratum was composited with other like sediment material from the respective OU2s. This process created the following composite samples for each OU2 during Step I and Step II sampling (Table 4):

- Willow Street OU2 – 10 composite samples
- Division Street OU2 – 14 composite samples
- North Station OU2 – 3 composite samples

Samples were submitted to CGC, Inc., for analysis of grain size, Atterberg limits, organic content, and moisture content. Compressive strength was recorded on the boring logs using a Torvane hand-held shear device. Laboratory results are provided in Appendix E4.

3.7.3.7 Sediment Benthic Assessment

A qualitative benthic invertebrate survey was completed during Step I sediment sampling to evaluate the presence/absence of bottom-dwelling species. Grab samples of surface sediment were collected at two locations at the Willow Street OU2 on November 13, 2012, per the USEPA-approved SSWP, Revision 2 (NRT 2011b), at two locations at the Division Street OU2 on November 12, 2013, in accordance with the approved SSWP, Revision 1 (B&McD2009b), and at two locations at the North Station OU2 from November 12 to 15, 2012, per the approved SSWP, Revision 1 (NRT 2012). Using a petite ponar sampler, samples of surface sediment (0-0.5 feet below mudline) were collected for evaluation of presence or absence of benthic invertebrates and stored on ice until evaluation. Samples were collected from the following locations at each OU2 (see Figures 8A through8C):

- Willow Street OU2 - surface water sampling locations SWS-1WHS and SWS-2WHS
- Division Street OU2 – sediment poling locations STA-21DSS and STA-30DSS
- North Station OU2 – sediment poling locations PCA-31NOS and PCA-33NOS

Evaluation was performed by an NRT biologist, following the general approach described in Section 4 of the Multi-Site FSP, Revision 4 (IBS 2008).

3.7.3.8 Sediment NAPL Mobility Testing

Thirteen sediment sampling locations where NAPL, defined as oil-wetted or oil-coated sediment, was identified during drilling were revisited and blind drilled to a predetermined depth. Material was then sampled and submitted to PTS Laboratories for analysis of grain size distribution, Atterberg limits, and free product mobility/residual saturation (Modified ASTM International, Inc. [ASTM] D425 and API RP40 [Dean-Stark Method]). To capture the affected sediment, undisturbed cores from each location were collected, frozen on dry ice, and shipped to the lab. Samples were collected at the following locations in each OU2 (Figures 13A through 13C):

- Willow Street OU2 – five undisturbed cores from five locations (PCA-13WHS-MOBILITY, PCA-15WHS-MOBILITY, PCA-32WHS-MOBILITY, PCA-40WHS-MOBILITY, and PCA-43WHS-MOBILITY) were collected from December 6 to 13, 2013.
- Division Street OU2 – five undisturbed cores from the five locations (STA-8DSS-MOBILITY, STA-19DSS-MOBILITY, STA-22DSS-MOBILITY, STA-45DSS-MOBILITY, and STA-71DSS-MOBILITY) were collected from December 6 to 10, 2013.
- North Station OU2 – three undisturbed cores from two locations (PCA-12NOS-MOBILITY and PCA-32NOS-MOBILITY) were collected from December 6 to 13, 2013.

A summary of the samples collected and description of the sampled intervals are provided in Table 5A. NAPL elevation in relation to the USACE federally authorized channel depth is presented in Table 5B.

3.7.3.9 Investigation-Derived Waste Analysis

IDW material was sampled following the investigation activities. Composite samples were collected and submitted to Pace Analytical for analysis of disposal parameters for waste characterization. Disposal of IDW is further discussed in Section 3.11.

3.8 SURFACE WATER SAMPLING AND INVESTIGATION

3.8.1 Surface Water Sampling Locations

Samples were collected based on methods included in the SSWP, Revision 2 (NRT 2011b), for the Willow Street OU2, the SSWP, Revision 1 (B&McD 2009b), for the Division Street OU2, and the SSWP, Revision 1 (NRT 2012), for the North Station OU2.

As described in the SSWPs, during both the Step I and Step II sampling events, surface water was collected at four locations within the ambient area upstream of the OU2s and at four locations within OU2 at Willow Street, Division Street, and North Station (see Figures 8A through 8C). The locations were selected to assess water

quality in both the ambient and OU2 areas for use in future remedial alternative evaluations. Sample numbers were designated the nomenclature as follows:

- Ambient (or upstream) area – SWA-#DVS and SWA-#WHS
- Willow Street OU2 – SWS-#WHS
- Division Street OU2 – SWS-#DIV
- North Station OU2 – SWS-#NOS

Sampling events occurred in December, 2011 (Willow Street and Division Street), prior to the Step I sediment sampling event and in November, 2012 (Willow Street, Division Street and North Station), prior to the Willow Street and Division Street Step II and North Station Step I sediment sampling events.

3.8.2 Surface Water Sampling Methods

OU2 and ambient surface water sampling as part of the Willow Street and Division Street Step I investigation was conducted from December 12 to 14, 2011. The second round of Willow Street and Division Street surface water sampling, and first round of North Station sampling, was completed between November 12 and 14, 2012. Surface water samples were collected using a peristaltic pump with the tubing attached to a pole, in accordance with USEPA-approved SOP SAS-09-01 and Section 4 of the Multi-Site FSP, Revision 4 (2008), and submitted to Pace Analytical and Test America laboratories for analysis, in accordance with the SSWP, Revision 2 (NRT 2011b), for the Willow Street OU2, the SSWP, Revision 1 (B&McD 2009b), for the Division Street OU2, and the SSWP, Revision 1 (NRT 2012), for the North Station OU2.

Prior to sample collection, surface water at each location was pumped through a flow-through cell to measure field parameters, including pH, temperature, dissolved oxygen (DO), oxidation-reduction potential (ORP), conductivity, and turbidity.

At the Division Street OU2, two discrete sub-samples were collected from each location during each event: one sample at 0.2 and one at 0.8 times the total water depth. The two sub-samples from each location were combined prior to submittal to the laboratories for a single composite surface water sample from each location. At both the Willow and North Station study areas, grab samples were collected at 0.8 times the total water depth and submitted to the laboratories for analysis.

At each surface water sampling location, the water velocity was also recorded. Water velocity was measured in accordance with Section 4 of the Multi-Site FSP, Revision 4 (IBS 2008). A digital velocity meter attached to a ridged steel rod was used to record river velocity from the sampling boat. After the sampling location was poled, the velocity meter was lowered into the water column. The velocity measurements were collected at 0.8 times (and 0.2 times for Division Street locations) the total water column depth, or 13 feet below water surface (note that the full 0.8 depth could not be achieved at all locations, because the velocity meter had maximum reach of 13 feet below water surface). The velocity meter was rotated around until the maximum velocity was recorded on the display. The average and maximum velocity at each depth and each location were also recorded. Actual sampling locations were recorded using a GPS unit in accordance with the methods described in Section 7 of the Multi-Site FSP, Revision 4 (IBS 2008).

Surface water sampling locations are shown on Figures 8A through 8C. Field data forms documenting this activity are included in Appendix D5.

3.8.3 Surface Water Chemical Analysis

Based on USEPA, dissolved constituents, rather than total constituents, more closely approximate the bioavailable fraction of metal in the water column (USEPA 1993). As such, surface water samples were filtered and dissolved metals were analyzed during the December 12 to 14, 2011, sampling event at the Willow Street and Division Street OUs. Surface water samples were not filtered during the November 12 to 14, 2012, water sampling event for Willow Street, Division Street, and North Station, and whole samples were submitted for analysis of total inorganic constituents. Analyzing for total metals is a more conservative approach than proposed in the SSWP, Revision 1 (NRT 2012), and results can be directly compared to screening levels (SLs).

Samples were analyzed for applicable OU2 site-specific COPCs (*i.e.*, PAHs, phenols, metals, PVOCs, PCBs, and hardness) by Pace Analytical. Available cyanide analysis was performed by Test America.

3.9 DEVIATIONS FROM THE SSWP

Guidance for implementing the RIs at each OU was provided in the following USEPA-approved documents: SSWP, Revision 2 (NRT 2011b,) for Step I and Step II work at the Willow Street OU; SSWP, Revision 1 (B&McD 2009b), for Step I and Step II work at Division Street OU; and, SSWP, Revision 1 (NRT 2012), for Step I work at the North Station OU. In limited situations, deviations from the documents were required based on field conditions. Deviations were brought to the attention of the USEPA as the RI activities progressed and are listed in the sections below.

3.9.1 Willow Street OU2

Deviations from SSWP, Revision 2 (NRT 2011b), Section 6.6.6.3, were required based on field conditions during Step I and Step II sediment sampling activities. Step I and Step II sediment sampling deviations from the SSWP are summarized below.

1. Sediment cores were identified with a "PCA" prefix, as opposed to the "CCA" prefix that was proposed.
2. On the sediment thickness evaluation forms (Appendix D2), the locations are labeled slightly differently, WHS-PCA1 to WHS-PCA24, rather than PCA-1WHS to PCA-24WHS.
3. Borings at two locations were repositioned, due to refusal at original proposed location. PCA-11WHS was relocated to PCA-11AWHS, due to refusal at 4.5 feet below mudline; PCA-18WHS was relocated to PCA-18AWHS, due to refusal at 4 feet below mudline. Location PCA-16WHS was not used because of poor recovery; nearby PCA-16AWHS was drilled as an offset instead. Location PCA-22WHS was sampled by push core only, as the field team felt the location was likely to block River traffic and create a safety hazard if the sampling barge spudded down for an extended period of time at that location to use the drill rig.

3.9.2 Division Street OU2

Deviations from SSWP, Revision 1 (B&McD 2009b), Section 6.6.6.3, were required based on field conditions during Step I and Step II sediment sampling activities. Sediment sampling deviations from the SSWP are summarized below.

1. The SSWP only required 40 sediment core locations to be completed during the Step I sediment sampling. Four additional sediment core locations were completed as part of the Step I sediment sampling (STA-41DSS to STA-44DSS) to further define the downstream extent of impacts related to the former MGP.
2. The SSWP only required samples collected from 0.5 to 2.5 feet below the mudline to be submitted for analysis of COPCs from 20 of the 40 proposed sediment core locations. During the Step I sediment sampling, all samples collected from 0.5 to 2.5 feet below the mudline were submitted for analysis of COPCs from the 44 sediment core locations, except at core locations where sampling methods did not provide sufficient material due to poor recovery (STA-24DSS and STA-40DSS).
3. The SSWP required up to 4 samples collected deeper than 2.5 feet below the mudline to be submitted for analysis of COPCs from 20 proposed core analysis locations. During the Step I sediment sampling, up to 4 samples collected deeper than 2.5 feet below mudline were submitted for analysis of COPCs at 19 of the 20 proposed core analysis locations. Samples deeper than 2 feet below the mudline could not be collected at proposed core sample analysis location STA-14DSS, due to refusal of the core sampling device. Core samples were instead collected at proposed surface sediment sampling location STA-13DSS. Samples were collected deeper than 2.5 feet below the mudline at all four additional downstream sediment sampling locations, STA-41DSS to STA-44DSS. Overall, samples were collected deeper than 2.5 feet below mudline and submitted for analysis at 24 of the 44 sediment core locations completed during Step I sediment sampling.
4. The SSWP required the sequence of core locations sampled to start downstream and proceed toward the upstream end of the grid. In general, this sequence was followed during the Step I sediment sampling, however, location STA-38DSS was completed after completion of upstream locations, due to limited

accessibility caused by commercial barge traffic. Additional downstream locations STA-41DSS to STA-44DSS were completed last to further define the downstream extent of potential MGP impacts.

5. The SSWP required 20 samples collected from 0 to 0.5 feet below the mudline to be submitted for black carbon analysis and 10 samples collected from 0 to 0.5 below the mudline to be submitted for ammonia and sulfide, to support toxicity testing evaluation. During the Step I sediment sampling, 24 samples were collected from 0 to 0.5 feet below the mudline and submitted for black carbon analysis, including those collected from locations STA-41DSS to STA-44DSS. No samples were collected for ammonia or sulfide during the Step I sediment sampling because, as described in Enclosure B, *Summary of Ambient Area Sediment Investigation Toxicity Test Results and Related Sediment Chemistry Results* (Exponent 2011) the concentrations of TPAHs in the ambient area are within the range of being considered toxic to benthic invertebrates, and OU2 toxicity sample analysis would not be useful in differentiating any difference in degree of toxicity between the ambient and OU2 conditions.
6. The SSWP required that at least 10 of the deeper sediment samples (deeper than 2.5 feet below mudline) be analyzed for the 34 alkylated PAHs and black carbon. To further delineate the extent of effects at depth in the sediment profile, a total of 15 deeper sediment samples were analyzed for 34 alkylated PAHs and black carbon.
7. The SSWP required up to 12 sediment cores be collected and submitted for analysis of geotechnical parameters (Atterberg limits, grain size, organic content, and moisture content) for use in the FS. During the Step I sediment sampling, no sediment cores were analyzed for geotechnical parameters, only composite samples were submitted for laboratory analysis, as previously described in Section 3.7.3.6. Sediment cores were collected and submitted for geotechnical parameter analysis, as part of the Step II sediment sampling.

Step II sediment sampling was completed from August to December, 2013, to further define the vertical and horizontal extent of potential MGP residuals and provide additional data for future evaluation of potential remediation areas. The February 20, 2013, Technical Memorandum, *Step I Data Evaluation for North Branch Sediment Sampling North Branch Chicago River, Willow Street Station, and Division Street Station Former MGP*s, describes the Step II sediment sampling plan and additional data collection necessary to complete the RI, following the Step I sediment sampling and data evaluation. Deviations from this Technical Memorandum were required, based on field conditions during Step II sediment sampling activities. Step II sediment sampling deviations from the Technical Memorandum are summarized below.

1. In addition to the seven revisit locations to confirm the depth of clay (Step II borings identified with the suffix "RVT"), all other sediment sampling locations (43) completed during the Step II sediment sampling were extended at least 1.9 feet into native material, for the purpose of confirming clay elevation. Clay elevation data from the 43 Step II sampling locations, in addition to the Step I and revisit data, is sufficient to confirm the elevation of clay in OU2.
2. The Technical Memorandum required 17 borings to be advanced during the Step II sediment sampling for the purpose of further defining the horizontal extent of NAPL visually observed during the Step I sediment sampling. All 17 borings proposed in Figure 6 of the Technical Memorandum were completed. In addition, all 50 borings completed during the Step II sediment sampling were logged and observations of NAPL or oil-coated/oil-wetted materials were recorded. The additional boring locations used to further define the horizontal extent of NAPL were selected based on field observations, as well as the protocol for selecting new borings described in the Technical Memorandum.
3. The Technical Memorandum specifies that two borings will be advanced during the Step II sampling for the purpose of defining the vertical and horizontal extent of elevated PAHs (*i.e.,* TPAH concentrations greater than the UTL). Both of the proposed borings were completed during the Step II sediment sampling event. Additional borings were also located, based on the protocol described in the Technical Memorandum, and advanced surrounding locations of known UTL exceedances based on data from both Step I and Step II sediment sampling events.

4. Additional geotechnical composite samples (5) and discrete sediment Shelby tube samples (5) were collected and analyzed during the Step II sediment sampling event for the purpose of further defining sediment geotechnical parameters for use in the FS.

3.9.3 North Station OU2

Deviations from SSWP, Revision 1 (NRT 2012), Section 6.6.6.3, were required based on field conditions during Step I sediment sampling activities.

1. Surface water samples were not filtered, as was proposed in the SSWP, Revision 1 (NRT 2012). Samples were submitted to the lab as whole samples for analysis of total inorganic constituents, except for cyanide. Further discussion can be found in Section 4.5.
2. Cores for chemical sampling were identified with a "PCA" prefix as opposed to the "CCA" prefix that was proposed in Section 6.6.6.3 of SSWP, Revision 1 (NRT 2012).
3. Several proposed drilling locations were modified, due to surface or subsurface obstructions or utility clearance issues. Modified locations were placed as close as possible to proposed locations.
4. During field operations, NRT questioned the City about the position and activity of a historic utility line marked with signage near boring location PCA-NOS24. Despite the line being out of use, City recommended not drilling in the area. Therefore, this location was only sampled to 3.5 feet below mudline with a push core.
5. One full-scale surface water sampling event was conducted. Additional surface water sampling was not conducted because a benthic community assessment (and corresponding surface water sampling) was not identified as a data need, and additional sediment sampling beyond Step I has not been conducted.
6. Step II sediment sampling was not conducted because calculation of a site-specific risk value based on ecological receptors has not been identified as a data gap for evaluation of OU2 sediment quality compared to ambient sediment.

3.10 SAMPLE VALIDATION AND QA/QC

Pace Analytical and Test America, previously approved in the Multi-Site QAPP, Revision 2 (IBS 2007c), were the laboratories used for chemical analysis of sediment and surface water samples. Additional sediment analyses for geotechnical parameters and NAPL mobility were conducted by CGC, Inc., and PTS Laboratories, respectively.

Trip blanks, duplicate samples, and MS/MSD samples were collected and analyzed to satisfy QA/QC requirements, in accordance with Section 2 of the Multi-Site QAPP, Revision 2 (IBS 2007c).

3.10.1 Data Validation and Verification

All sediment and surface water chemical data collected during the RI field activities were reported as part of a Level IV package and subject to a third-party validation review. Shepherd Technical Services, in Austin, Texas, validated laboratory procedures and sample results for Pace Analytical and Test America, as discussed in Section 4 of the Multi Site QAPP, Revision 2. Validation was conducted in accordance with the requirements of the Multi-site QAPP, Revision 2. The validation provided additional data flags including data that were rejected. The validation summaries are included in Appendix G1 through G3.

The data validation reports calculated the relative percent differences (RPD) between parent and duplicate samples and percent recoveries of MS/MSD samples, to assess precision and accuracy of the data sets. RI activities were performed in accordance with the SOPs included in the Multi-Site FSP, Revision 4 (IBS 2008), and Multi-Site QAPP, Revision 2 (IBS 2007c), to minimize errors and ensure representativeness.

As a result of USEPA comments, "N" qualifiers (denoting "normalized" values) are used in the data tables to denote sample results where both parent and duplicate sample values were incorporated into the determination of the data value. A brief summary of the sample generation procedure for parent/duplicate sample pairs is described below.

- If both sample results have a detection for an analyte, the greater of the two was presented.

- If only one sample has a detection for an analyte, the detected value was presented.
- If both sample results are non-detect for the analyte, the lower detection limit was presented.
- If a sample result is flagged as rejected by the validator flag (typically using the flag "R"), the other sample result for that analyte was presented.
- If there is only one sample result for an analyte, that result was presented.

RPD tables for sediment and surface water are presented in Appendix H.

3.10.2 Data Evaluation and Tabulation for Risk Assessment

Verified and/or validated data was entered into a database and tabulated for use, as described in the Multi-Site QAPP, Revision 2 (IBS 2007c). Procedures for assessing the precision, accuracy, representativeness, completeness, and comparability of field and analytical laboratory data were followed, as described in Section 4 of the Multi-Site QAPP, Revision 2, and USEPA-approved SOPs SAS-04-01, SAS-04-02, and SAS-04-03, from the Multi-Site FSP, Revision 4 (IBS 2008).

Analytical results are organized in a logical manner, indicating the unique sample identification number corresponding to the sample/location, sampling date and time, sample depth, detection limits, analytical results (following the units of measurement presented in the Multi-Site QAPP, Revision 2, Table 9), and validation qualifiers, if appropriate. This information is presented in Appendix G1 for OU2 sediments, Appendix G2 for ambient samples, and Appendix G3 for surface water.

3.10.3 Discussion of Field Duplicates

Parent and duplicate samples were summarized into tables by sample media and included in Appendices G4 and G5. The RPD was calculated for each pair, and the pairs were compared to the SL for reference to see if the difference between pairs would result in additional exceedances.

Surface water calculated RPDs, presented in Appendix H1, generally meet the precision goal of 30% stated in the Multi-Site QAPP (IBS 2007c). For the samples that exceed the 30%, 12 out of 13 comparisons are reported to be below applicable PAH SLs analytes, with one parent sample (SWS-1DIV) reported to be above applicable SLs for benzo(a)pyrene. A single parent sample was reported to exceed dissolved lead SLs (SWS-3DIV). As a conservative step, as described in Section 3.10.1, the highest result between the parent and duplicate sample was selected and presented on the data tables, so it appears as an SL exceedance.

There were numerous instances in sediment samples, presented in Appendix H2, where the RPD exceeded the 30% precision goal. This was observed in sample sets collected in both 2012 and 2013, and across the compound list. As a conservative approach in data review, as described in Section 3.10.1, when assessing and screening data, the highest result from the parent or duplicate sample was selected for screening and risk assessment purposes.

3.11 DISPOSAL OF INVESTIGATIVE-DERIVED WASTE

Investigative-derived wastes (IDW) were containerized during RI activities prior to disposal off-site. Sediment and surface water IDW were disposed of through Van Hoesen Industries, Inc. d/b/a North Branch Environmental of Roselle, Illinois. All disposal activities were completed in accordance with applicable state and federal regulations and the methods described in Section 9 of the Multi-Site FSP. Waste manifests can be found in Appendix E8.

3.12 RECORD KEEPING

Detailed field and laboratory records, and data management and storage were conducted in accordance to the Multi-Site QAPP, Revision 2 (IBS 2007c), and Multi-Site FSP, Revision 4, and SOP SAS-01-02 (IBS 2008).

4 INVESTIGATION OBSERVATIONS AND RESULTS

This section summarizes the nature and extent of MGP residuals in sediment and surface water within the areas of concern identified across the Site. Nature and extent presented in this section is based on a combination of field observations made during field investigation/sample collection, as well as comparison of laboratory analytical results against applicable screening criteria. The statistic used to characterize sediment in the ambient area is the UTL, as described in Section 3.7.2. For analytes with no discernable UTL from the development procedure described in Section 3.7.2, human health and ecological SLs from the Multi-Site RAF (Exponent 2007) were used as a point of comparison. Sediment concentration data for sample locations collected from the OU2 investigative areas can be compared to the ambient UTLs and relevant Multi-Site RAF SLs to determine if a sample location in the investigative area is consistent with ambient conditions or potentially affected by the MGP. Thus, a chemical concentration above the ambient UTL, or human health and ecological SLs, collected within the investigative area represents a location where MGP-related effects are potentially present. Surface water concentrations were compared to CAWS SLs and Multi-Site RAF ecological SLs.

Please note, for the purposes of data discussion and presentation, surface sediment in Section 4, figures, and tables, is referred to as the interval between 0 and 1.5 feet below the mudline. This is due to TPAH UTL screening surface interval being increased to a depth of 1.5 feet below the mudline. Sediment greater than 1.5 feet below mudline is referred to as subsurface sediment.

4.1 AMBIENT SEDIMENT

A study of ambient sediment upstream of the Site, and out of the area of influence of the former MGPs, has been conducted to identify background sediment quality in the River in the area of the Site. Ambient sediment sampling was conducted in 2011. Select surface sediment samples were analyzed for chemical constituents and toxicity using the test organism *Hyalella azteca, as* described in Section 3.7.2.4.

Details of the ambient sediment investigation and results were provided in Enclosure B of the Step I Data Evaluation, Revision 2 (NRT 2013) (Appendix E1). A brief summary of the ambient sediment investigation results is included below, and a summary of the UTLs is presented in Table E, below. Ambient analytical data is presented in Table 6.

4.1.1 Chemical Sampling

Results of the ambient sediment investigation indicate that the River sediments upstream of the North Branch MGP Site, and out of the area of influence of the former MGPs, contain relatively high concentrations of TPAHs and metals. Elevated results for toluene are also reported in samples collected in the ambient samples. The concentrations of TPAHs, and many of the metals, in sediment of the ambient study area are orders of magnitude greater than their respective screening-level ecological benchmarks. For this reason, accounting for degraded ambient conditions of the River is an important point of comparison relative to conditions at the Site.

To compare ambient sediments to site sediments, ambient sediment investigation results were used to develop UTLs for metals, available cyanide, and TPAHs in ambient sediment. Further description of the UTL is provided in Section 3.7.2.2.

The TPAH UTL was developed using the sum of 13 PAHs because this list of PAHs was specifically used to develop the consensus-based TPAH ecological SLs for sediments (MacDonald *et. al.* 2000) that are used as a point of comparison in ecological risk evaluations. The list of the 13 PAHs used in the calculation are: acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, fluoranthene, fluorene, naphthalene, phenanthrene, and pyrene.

This sum of 13 PAHs (TPAHs) in sediment has also been used as an indicator of toxicity of PAHs at other former MGP sites within the Multi-Site MGP Program. Surface and subsurface concentrations of TPAHs were statistically different in the ambient reach; therefore, separate UTLs were developed for each depth grouping. In addition, samples collected from 0 to 0.5 feet did not correlate (Appendix E9) with samples collected from 0.5 to 1.5 feet so were used to calculate the surface UTL (0 to 1.5 feet). The surface interval was increased from 0-0.5 feet to

0-1.5 feet to increase the dataset. Unless otherwise specified in this document, the term "Total PAHs" refers to the sum of 13 PAHs.

UTLs for metals and cyanide were also developed (Step I Data Evaluation, Revision 2 [NRT 2013]), however, different UTLs by sediment depth were not necessary for these analytes, because metal concentrations did not appear to vary by depth (Table 6). Table E below summarizes the calculated ambient UTLs. The UTLs developed from the ambient sediment data set were used to screen sediment sampling results at the Willow Street, Division Street, and North Station OU2s. This is discussed in more detail in Section 4.4.

Table E. Ambient UTL Summary

Analyte	UTL (mg/kg)
TPAHs (surface)	342
TPAHs (subsurface)	410
Aluminum	16,118
Antimony	13
Arsenic	30
Barium	555
Cadmium	133
Chromium	829
Copper	1,048
Cyanide, Total	13
Iron	71,400
Lead	863
Manganese	690
Mercury	10
Nickel	190
Selenium	5
Silver	18
Vanadium	70
Zinc	2,112

4.1.2 Toxicity Testing

Results of the ambient sediment investigation indicate that River sediments upstream of the Site, and out of the area of influence of the former MGPs, exhibit a moderate level of toxicity. In addition to relatively high concentrations of TPAHs and metals in ambient sediments, this is another indication that accounting for degraded ambient conditions of the River is an important point of comparison, relative to conditions within individual OU2 sites.

Data analysis included in the Step I Data Evaluation, Revision 2 (NRT 2013), concluded that observed ambient sediment toxicity was primarily associated with some metals and, to a lesser extent, Total PAHs. Based on the moderate level of toxicity in ambient sediments and these results, it was determined that site-specific sediment toxicity testing at the Sites would not be useful in characterizing MGP-related ecological risk zones associated with effects on sediment. Therefore, toxicity testing at the Site was not performed during this investigation. Details of this conclusion are described in Step I Data Evaluation, Revision 2 (NRT 2013), and included in Appendix E1.

4.2 OU2 MORPHOLOGY AND FLOW

4.2.1 Willow Street OU2

Based on the bathymetric survey data obtained by ASE of Chicago on December 16, 2011 (see Appendix C2 and Figure 9A), the River is approximately 200 feet wide at the water surface and 50 to 60 feet wide at the channel bottom in Willow Street OU2. The River sediment elevation varies from approximately 567 to 572 feet above mean sea level ([NAVD88], the basis for all project sediment vertical reference going forward), at the shoreline, with relatively gentle slopes of about 8H:1V (horizontal to vertical) to 12H:1V toward the bottom. The River bottom elevation ranges from approximately 565 feet at the upstream end of the surveyed area to approximately 561 feet at the downstream end of the surveyed area, at the West North Avenue Bridge.

The December, 2011, channel bottom elevations are approximately 4 to 8 feet lower than the USACE historical dredge elevation in this area (569 feet). Unaware of other dredging that may have occurred in this area, this suggests the center of the channel adjacent to the former MGP has scoured since it was last dredged or was over-dredged. USACE dredging, downstream of the West North Avenue Bridge every few years prior to 1966, suggests a depositional environment in the turning basin and downstream, which required dredging to maintain operational depth. However, without historical bathymetric data, it is difficult to draw definitive conclusions regarding sediment erosion/deposition.

Surface water physical properties, including water velocity, were collected on December 12, 13, and 14, 2011, from four locations in OU2 and four locations upstream of the Willow Street OU2, using a digital water velocity meter. The recorded velocity for all eight locations was less than 1 foot per second (fps), the minimum measurable velocity of the equipment. Low velocities suggest a flow system that is more depositional than erosional.

Results of the sidescan sonar imaging in the OU2 (Appendix C3) indicate some collapsed dolphins or debris located near the West North Avenue Bridge. No other obstructions or submerged features are prominent in the image. The river bottom in this area is relatively flat or sloping, and it is not characterized by deep holes or mounds that would suggest the presence of preferential scour or deposition.

4.2.2 Division Street OU2

Based on the bathymetric survey data obtained for NRT by ASE of Chicago in December, 2011 (see Appendix C2 and Figure 9B), the River is approximately 120 feet wide at the water surface and 30 to 75 feet wide at the channel bottom in the Division Street Station OU2. The channel bottom elevation varies from approximately 560 to 568 feet along the east bank, 559 to 570 feet along the west bank, and minimum elevations mid-channel up to approximately 560 feet. Sediment within the River have relatively gentle slopes of about 8H:1V to 12H:1V toward the bottom. The maximum survey elevation identified is approximately 570 feet in small areas immediately adjacent to the west bank. The river bottom in this area is relatively flat or sloping, and it is not characterized by deep holes or mounds that would suggest the presence of preferential scour or deposition.

Surface water velocity was measured at four locations during surface water sampling in the OU2 in November, 2012. The recorded surface water velocity at all four sampling locations was less than 1 fps, the minimum measurable velocity of the equipment.

Results of the sidescan sonar imaging in the OU2 (Appendix C3) indicate some debris or dolphins located near the Division Street Bridge. No other obstructions or submerged features are prominent in the image.

4.2.3 North Station OU2

Based on the bathymetric survey data obtained by ASE of Chicago in January, 2013 (see Appendix C2 and Figure 9C), the Canal is approximately 90 to 100 feet wide at the water surface and 20 to 80 feet wide at the channel bottom in the North Station OU2. The River sediment elevation varies from approximately 563 to 571 feet along the east bank, 565 to 572 feet along the west bank, and minimum elevations mid-channel up to approximately 561 feet. Sediment within the River have relatively gentle slopes of about 8H:1V to 12H:1V toward the bottom. The maximum survey elevation identified is approximately 575 feet in small areas

immediately adjacent to the east bank. Sediment slopes in these areas approach 4H:1V. The river bottom in this OU2 is relatively flat or sloping, and it is not characterized by deep holes or mounds that would suggest the presence of preferential scour or deposition.

Surface water velocity was measured during surface water sampling in the OU2 in November, 2012. The recorded surface water velocity at all four sampling locations was less than 1 fps, the minimum measurable velocity of the equipment.

Results of the sidescan sonar imaging in the OU2 indicate an obstruction is present in the Canal (Appendix C3). A sunken vessel appears on the river bottom along the west bank, just downstream of the upland OU1. Marker buoys are also located in this area of the Canal. Remnants of a vessel known as the Showboat Sari II, or Sari-S are known to rest in this area, based on an article published by the Chicago Tribune (Recktenwald 1992). Additionally, some dolphins or debris can be seen near the Division and Halsted Street bridges. No other obstructions or submerged features are prominent in the sidescan images.

4.3 OU2 LITHOLOGY AND MGP RESIDAULS

Where appropriate, results of findings from all Step I and Step II sampling events from 2012 to 2013 are combined and summarized in this section.

4.3.1 Lithology

Two distinct stratigraphic units are present within the North Branch River: native lean clay, interpreted as the Carmi member of the Equality Formation, and overlying soft sediment. Observations of River lithology are summarized below, illustrated on cross sections (Figures 10A through 12C), and recorded on boring logs in Appendix D4.

Soft sediment was observed in all boring locations and was described as dark gray to black in color, soft to very soft, with organics and trace granular material throughout. Sediment was observed to be between 4.5 feet (STA-63DSS) to 22.5 feet thick (STA-21DSS-RVT) within the OU2s.

Borings in the OU2s reached lean clay at depths ranging from 4.5 feet below mudline at STA-63DSS to 22.5 feet below mudline at STA-21DSS-RVT. Clay was described as grayish brown to dark gray, soft to stiff, varying plasticity, and with trace fine sand and gravel in some locations. Clay was not observed to be fractured. Silty clay, up to 2 feet in thickness, was described to be above the clay at a small number of locations. Boring locations where the 2012 borings did not reach clay beneath sediment were revisited and re-drilled into clay during 2013 field work. Borings that were revisited in 2013 for this purpose, or revisited and re-drilled for any reason, have a boring ID suffix of "RVT."

Nine geotechnical borings were advanced greater than 4 feet into the lean clay within the Willow Street and Division Street OU2s. Boring locations Geotech 5, Geotech 7, and Geotech 8 were terminated at 50 feet below mudline (the maximum permitted depth) in lean or silty clay. Weathered bedrock was encountered in one boring location, STA-83DSS/Geotech 9, at 41.5 feet below mudline. The other locations terminated at varying depths within the clay, between 35 feet and 43.5 feet. Logs from borings that reached bedrock during the early stages of the TARP design were obtained from the MWRD. Three borings, DS-64, DS-65, and DS-69 (conducted between 1975 and 1976), were advanced along the North Branch River OU2s and indicate fractured dolomite limestone being encountered between 519.5 and 525.7 feet above mean sea level ([NAVD88] Appendix A1).

4.3.2 Observations of MGP Residual in Sediments

Results summarizing observations of MGP residuals in sediments in the Site are presented below and illustrated on Figures 13 through 13C (Surface Sediment Observations), Figures 14A through 14C (Subsurface Sediment Observations), and Table 5B (Summary of Elevation of DNAPL Observations). Results are separated by OU2 investigation areas for discussion.

4.3.2.1 Willow Street OU2

NAPL, in the form of oil-wetted or oil-coated sediment, was not observed at any of the 24 poling locations (WHS-PCA01 to WHS-PCA24). As stated in Section 3.7.3.2, sheen was encountered during poling at one location (PCA-1WHS) and slight or faint sheen was encountered during push-coring at four locations (PCA-8WHS, PCA-20WHS, PCA-21WHS, and PCA-22WHS). Location PCA-1WHS is in central channel upstream of the OU2; location PCA-8WHS is near the west bank adjacent to the OU; and locations PCA-20WHS, PCA-21WHS, and PCA-22WHS are downstream of the OU2 and near the center or east bank of the channel (see Figure 13A for observations within the top 1.5 feet of sediment).

NAPL, in the form of oil-wetted or oil-coated sediment, was observed in six out of 57 sediment borings completed in OU2: five locations adjacent to the former MGP property, and one location less than 150 feet downstream of the former MGP property boundary. The six locations and associated depths below mudline can be found on Figure 14A and in boring logs of Appendix D4. Oil-wetted or oil-coated sediments were observed at depths ranging from 2.5 feet below mudline at PCA-32WHS, located at the east bank adjacent to the upland OU, to 14.5 feet below mudline at PCA-13WHS, located in the same area. In all but two locations (PCA-32WHS and PCA-15WHS-RVT, located with 30 feet of each other), oil-wetted or oil-coated sediments were observed directly on top of lean clay (silt or silty clay). No oil-wetted or oil-coated observations were observed within the lean clay. Thicknesses of oil-wetted or oil-coated sediment ranged from 0.5 to 6 feet, and were not observed in surface sediment (the top 1.5 feet of sediment, Figure 13A).

All six observed NAPL intervals occur at an elevation below the historical USACE federally authorized channel depth as further discussed in Section 4.4.14.1. Table 5B summarizes the elevation at these locations, which range between 4 and 18 feet below the USACE federally authorized channel elevation of 569.71 feet (NAVD88).

4.3.2.2 Division Street OU2

Faint visible sheen was observed on the water surface at 10 of the 40 poling locations (see Figure 8B and Figure 13B for observations within the top 1.5 feet of sediment).

NAPL, in the form of oil-wetted or oil-coated sediment, was observed in 29 out of 94 sediment borings completed in OU2 at locations upstream, adjacent to, and downstream of the former MGP property boundary. The 29 locations and associated depths below mudline can be found on Figure 14B and in boring logs of Appendix D4. These locations are most densely grouped adjacent to the upland OU, tapering off just upstream (north) of the former MGP facility boundary and the Division Street Bridge, and downstream, approximately 800 feet from the south end of the upland MGP facility boundary.

Oil-wetted or oil-coated sediments were observed at depths ranging from 2.9 feet below mudline at STA-24DSS, located near the central river channel adjacent to the upland OU, to 22.5 feet below mudline at STA-1DSS-RVT, located near the west bank just north of the Division Street Bridge. Thicknesses of oil-wetted or oil-coated sediment ranged from 0.1 to 4 feet, but were generally 2 feet or less, and were typically observed directly on top of lean clay. No oil-wetted or oil-coated sediments were observed in surface sediment (the top 1.5 feet of sediment, Figure 13B). Occasionally, observations of oil-wetted or oil-coated material penetrated up to 1 foot into the lean clay at some locations. Twenty-five of the 29 locations where NAPL was observed in the OU2 was greater than 6 feet below mudline, and included weathered tar-like pieces and oil-coated sediment (Figure 14B and Appendix D4).

Three (STA-1DSS-RVT, STA-54DSS, and STA-64DSS) of the 29 NAPL intervals observed within the Division Street Station OU2 occur at an elevation above the historical USACE federally authorized channel depth of 557.51 feet (NAVD88) as further discussed in Section 4.4.14.1. NAPL elevations were calculated to be between 1.1 feet above and 8.2 feet below the historical USACE federally authorized channel depth. Location STA-24DSS was also calculated to above the USACE authorized channel depth of 557.51 feet (NAVD88) when compared to bathymetry survey data. Table 5B summarizes the elevation of NAPL observations which are also shown on Figure 14B.

4.3.2.3 North Station OU2

No sheen was observed on surface water during poling activities of the 33 sampling locations. Sheen was present in some samples during push-coring at the same locations (Appendix D2). Sheen was observed during push-coring at 12 of the 33 push-coring/poling locations, and heavy sheen was observed at one location (PCA-14NOS, in the eastern half of the Canal, adjacent to the upland OU).

NAPL, in the form of oil-wetted or oil-coated sediment, was observed in three of 33 sediment borings completed in OU2. The three locations, near the upland OU1, and associated depths below mudline, are indicated on Figure 14C and in boring logs of Appendix D4.

No oil-wetted or oil-coated sediments were observed in surface sediment (the top 1.5 feet of sediment, Figure 13C). In the subsurface, NAPL was encountered at depths ranging from 4.5 feet below mudline at PCA-33NOS, located at the east bank adjacent to the upland former MGP facility, to 14.7 feet below mudline at PCA-32NOS, located in the same area. With the exception of one location, PCA-12NOS, oil-wetted or oil-coated sediments were observed directly on top of lean clay. Thicknesses of oil-wetted or oil-coated sediment ranged from 2 to 6.8 feet.

North Station is located on the North Branch Canal, which is not a navigable channel (Appendix A2). Table 5B summarizes the elevation of NAPL identified at the three North Station locations for reference.

4.3.2.4 Summary of NAPL Observations

- Sheen was observed during poling in Willow Street and Division Street OU2s.
- MGP residuals were observed in all three OU2s, at varying depths.
- Where MGP residual was observed, it was generally located directly above the lean clay (34 out of 38 boring locations). In the remaining four borings, MGP residuals were observed within the silt, at varying depths.
- Division Street OU2 had 29 of the 38 borings where NAPL was observed.
- Maximum thickness of sediment with oil-wetted or oil-coated material was 6.8 feet (STA-33NOS).
- Thirty of 38 NAPL observations were in borings adjacent to the upland OU1.
- Four of 35 locations within the USACE federally authorized channel were identified as having NAPL above the historical USACE federally authorized channel depths (STA-1DSS-RVT, STA-54DSS, STA-64DSS, and STA-24DSS). All four locations were within the Division Street Station OU2. North Station OU2 is located on the North Branch Canal, which is not part of the USACE federally authorized channel.

4.4 OU2 SEDIMENT DATA

The following subsections summarize the sediment sampling results (Tables 7A and 7B). As a reminder, for the purposes of data discussion and presentation, surface sediment in this section, figures, and tables, refers to sediment from 0 to 1.5 feet below the mudline. This depth interval corresponds to the interval used for calculating the TPAH UTL for screening surface sediment.

4.4.1 Total PVOCs in Sediment

Results summarizing PVOC (benzene, ethylbenzene, toluene, total xylene, 1,2,4-trimethylbenzene, and 1,3,5-trimethylbenzene) concentrations in sediment within the OU2s are presented in Tables 7A and 7B and are summarized below. Results are separated by surface and subsurface observations within each OU2 investigation area. No surface or subsurface UTLs were developed for PVOCs based on results of ambient sampling.

Box-whisker plots of range and median concentrations of BTEX (benzene, toluene, ethylbenzene, and xylenes), the only PVOCs consistently exceeding SLs were also created for each OU2. Spatial distribution of samples at each OU2 were divided into three main groups: 1) the group of samples collected within the upstream portion of the OU2 boundary; 2) the most downstream group of samples with a similar sample count as that found in the upstream sample group; and 3) all samples collected between the upstream and downstream groups were

divided into sub-groups (segments) with similar sample counts, to enable a reasonable comparison to upstream and downstream segments (Figures 29A through 29C). In addition, surface samples were also compared to ambient results as presented in Figure 30A through 30C. Results of the evaluation are described in subsequent sections below.

4.4.1.1 Willow Street OU2

A total of 92 surface sediment samples collected within Willow Street OU2 were analyzed for PVOCs. Results are summarized in Table F below.

Table F. Willow Street OU2 PVOC Surface Summary

PVOC	SLs (mg/kg)		Concentration (mg/kg)				# of Eco Exceedances	# of Construction Worker Exceedances
	ECO	Construction Worker	Minimum	Maximum	Arithmetic Mean	Median		
Benzene	0.308	2.2	0.0151	0.677	0.07	0.03155	1	0
Ethylbenzene	0.459	58	0.0186	0.446	0.08	0.0419	0	0
Toluene	0.383	42	0.0487	6.95	0.7	0.385	46	0
Xylenes, Total	0.465	5.6	0.0546	2.32	0.24	0.173	6	0
1,2,4-Trimethylbenzene	NS	219	0.0182	1.55	0.18	0.0965	0	0
1,3,5-Trimethylbenzene	NS	182	0.0199	1.01	0.1	0.0542	0	0

One surface sample, PCA-32WHS (0.677 milligrams per kilogram [mg/kg]), exceeded the benzene ecological SL of 0.308 mg/kg. Six exceedances of the ecological SL were reported for total xylenes. Of the 92 surface samples collected in Willow OU2, 46 exceeded the toluene ecological SL of 0.383 mg/kg. No construction worker PVOC SL exceedances were reported in surface sediment. Surface exceedance distribution is shown on Figure 15A.

A total of 196 subsurface samples collected within Willow Street OU2 were analyzed for PVOCs. Results are summarized in Table G below.

Table G. Willow Street OU2 PVOC Subsurface Summary

PVOC	SLs (mg/kg)		Concentration (mg/kg)				# of Eco Exceedances	# of Construction Worker Exceedances
	ECO	Construction Worker	Minimum	Maximum	Arithmetic Mean	Median		
Benzene	0.308	2.2	0.012	272	5.09	0.1435	62	34
Ethylbenzene	0.459	58	0.0118	762	16.58	0.27	71	10
Toluene	0.383	42	0.0133	112	1.74	0.256	54	1
O-Xylenes[a]	NS	6.5	1.29	200	34.7	10.8	NS	8
M&P Xylenes[a]	NS	6.4	4.15	418	71.3	23.9	NS	12
Xylenes, Total	0.465	5.6	0.047	222	6.61	0.306	68	33
1,2,4-Trimethylbenzene	NS	219	0.0133	255	6.68	0.4235	NS	1
1,3,5-Trimethylbenzene	NS	182	0.0174	81.6	2.43	0.206	NS	0

[a]2006 RSB boring locations analyzed for O and M&P xylenes.

In subsurface sediment, 62 (including 13 samples collected in 2006) of 196 samples collected exceed the benzene ecological SL of 0.308 mg/kg. Of the 62 ecological exceedances, 34 also exceeded the construction worker SL of 2.2 mg/kg. The maximum reported benzene SL exceedance for all three OU2s was reported in the 2006 Willow sample, WSS-RSB017-001, between 8 and 8.5 feet below mudline. The only 1,2,4-trimethylbenzene SL exceedance within all three OU2s was also reported in this sample. Subsurface PVOC distribution is presented in Figure 15B.

Results from a box-whisker analysis of BTEX data are presented in Figure 29A. Individual segments along the OU2 used in this analysis are presented in Figures 15A and 15B. Comparisons of individual BTEX compound concentration ranges and medians suggest elevated BTEX concentrations are present in OU2 sediment immediately adjacent to the Willow Street Station OU1 boundary. Constituent concentrations appear to decrease downstream of the Willow Street Station OU1 boundary. A similar picture exists when surface samples are compared to ambient results (Figure 30A).

4.4.1.2 Division Street OU2

A total of 178 surface samples collected within Division Street OU2 were analyzed for PVOCs. Results are summarized in Table H below.

Table H. Division Street OU2 PVOC Surface Summary

PVOC	SLs (mg/kg)		Concentration (mg/kg)				# of Eco Exceedances	# of Construction Worker Exceedances
	ECO	Construction Worker	Minimum	Maximum	Arithmetic Mean	Median		
Benzene	0.308	2.2	0.0229	1.06	0.13	0.0462	2	0
Ethylbenzene	0.459	58	0.0153	3.78	0.2	0.03615	3	0
Toluene	0.383	42	0.025	1.5	0.15	0.105	9	0
Xylenes, Total	0.465	5.6	0.084	0.884	0.2	0.13	1	0
1,2,4-Trimethylbenzene	NS	219	0.0199	1.49	0.08	0.0514	NS	0
1,3,5-Trimethylbenzene	NS	182	0.0217	3.78	0.15	0.046	NS	0

Eleven surface samples (8 boring locations) exceeded one or more of the applicable ecological SLs for PVOCs. In 8 of the 11 samples, toluene was the only compound to exceed an SL. No construction worker exceedances were reported. SL exceedance distribution is presented in Figure 16A.

Two hundred and sixty-two subsurface samples were analyzed for PVOCs in the Division Street OU2. Results are summarized in Table I below.

Table I. Division Street OU2 PVOC Subsurface Summary

PVOC	SLs (mg/kg)		Concentration (mg/kg)				# of Eco Exceedances	# of Construction Worker Exceedances
	ECO	Construction Worker	Minimum	Maximum	Arithmetic Mean	Median		
Benzene	0.308	2.2	0.0158	186	4.05	0.135	46	23
Ethylbenzene	0.459	58	0.0133	1020	16.73	0.11	41	6
Toluene	0.383	42	0.0108	106	1	0.0955	21	2
O-Xylenes	NS	6.5	1.29	200	34.7	10.8	NS	0
M&P Xylenes	NS	6.4	4.15	418	71.3	23.9	NS	0
Xylenes, Total	0.465	5.6	0.0494	444	9.18	0.315	52	18
1,2,4-Trimethylbenzene	NS	219	0.0121	157	2.88	0.144	NS	0
1,3,5-Trimethylbenzene	NS	182	0.0108	98.9	1.64	0.1225	NS	0

In subsurface sediment, the maximum benzene and other PVOC concentrations were observed at location STA-24DSS, on the east side of the channel, adjacent to the upland OU, and immediately downstream of the Division Street Bridge, in silt at a depth of 2.5-3.5 feet below mudline. This location was unique to the area, in that clay was encountered mixed with silt at a depth of only approximately 4.5 feet below mudline, much shallower than was typical for the Division Street OU2. In addition, strong odors and oil-wetted sediment were observed at that location and depth.

Of the 262 subsurface samples analyzed for PVOCs, 46 samples reported benzene SL exceedances of ecological SLs, with 23 of those exceedances also exceeding the construction worker SL of 2.2 mg/kg. Multiple exceedances of both ecological and construction worker SLs for ethylbenzene, toluene and xylenes were also reported. Figure 16B presents PVOC exceedances within the Division Street OU2 subsurface. SL exceedance distribution within Division Street OU2 subsurface is presented in Figure 16B.

Box-whisker plots of individual BTEX concentrations within Division Street OU2 were created to illustrate spatial distribution of constituents along the OU2 boundary. Individual segments along the OU2 used in this analysis are presented in Figures 16A and 16B. Samples were divided into three main groups as described above in Section 4.4.1 for this illustration.

Results from this box-whisker analysis are presented in Figure 29B. Comparisons of individual BTEX compound concentration ranges and medians suggest elevated BTEX concentrations, primarily benzene, are located within OU2 sediment immediately adjacent to upland Division Street Station OU1 boundary. Constituent concentrations appear to decrease downstream of the Division Street Station OU1 boundary. A similar picture exists when surface samples are compared to ambient results (Figure 30B) with the exception of toluene, where elevated concentrations appear in both the Division OU2 boundary and upstream, indicating there may be external sources resulting in a more widespread distribution of elevated toluene concentrations.

4.4.1.3 North Station OU2

A total of 65 surface samples collected within North Station OU2 were analyzed for PVOCs. Results are summarized in Table J below.

Table J. North Station OU2 PVOC Surface Summary

PVOC	SLs (mg/kg)		Concentration (mg/kg)				# of Eco Exceedances	# of Construction Worker Exceedances
	ECO	Construction Worker	Minimum	Maximum	Arithmetic Mean	Median		
Benzene	0.308	2.2	0.0128	0.168	0.06	0.0351	0	0
Ethylbenzene	0.459	58	0.0159	0.108	0.04	0.0345	0	0
Toluene	0.383	42	0.0431	0.527	0.12	0.0859	4	0
Xylenes, Total	0.465	5.6	0.0617	0.174	0.12	0.121	0	0
1,2,4-Trimethylbenzene	NS	219	0.0158	0.637	0.17	0.109	NS	0
1,3,5-Trimethylbenzene	NS	182	0.0218	0.305	0.09	0.0788	NS	0

In the North Station OU2 surface sediment, toluene was the only PVOC with ecological SL exceedances reported in 4 of 65 samples. No other ecological or construction worker SLs were reported. Figure 17A presents PVOC distribution within North Station OU2.

A total of 120 subsurface samples collected within North Station OU2 were analyzed for PVOCs. Results are summarized in Table K below.

Table K. North Station OU2 PVOC Subsurface Summary

PVOC	SLs (mg/kg)		Concentration (mg/kg)				# of Eco Exceedances	# of Construction Worker Exceedances
	ECO	Construction Worker	Minimum	Maximum	Arithmetic Mean	Median		
Benzene	0.308	2.2	0.021	10.1	1.3	0.4	36	14
Ethylbenzene	0.459	58	0.0117	59.2	5.76	0.317	29	1
Toluene	0.383	42	0.0233	1.3	0.13	0.0885	2	0
O-Xylenes	NS	6.5	1.29	200	34.7	10.8	NS	0
M&P Xylenes	NS	6.4	4.15	418	71.3	23.9	NS	0
Xylenes, Total	0.465	5.6	0.0519	33.1	4.96	1.605	45	15
1,2,4-Trimethylbenzene	NS	219	0.0114	30	3.7	0.6645	NS	0
1,3,5-Trimethylbenzene	NS	182	0.0236	8.22	1.17	0.649	NS	0

Thirty-six benzene ecological SL exceedances were reported, of which 14 also exceeded the construction worker benzene SL of 2.2 mg/kg. A similar distribution of exceedances was observed for ethylbenzene, toluene, and xylenes. Subsurface PVOCs at North Station OU2 are presented in Figure 17B.

Box-whisker plots of individual BTEX concentrations within North Station OU2 were created to determine spatial distribution of constituents along the OU2. Individual segments along the OU2 used in this analysis are presented in Figures 17A and 17B. Samples were divided into three main groups as described above in Section 4.4.1 for this illustration.

Results from this box-whisker analysis are presented in Figure 29C. Comparisons of individual BTEX compound concentration ranges and medians suggest elevated concentrations of BTEX constituents are located in OU2

sediment immediately adjacent to upland North Station OU1 boundary. A similar picture exists when surface samples are compared to ambient results (Figure 30B).

Surface and subsurface constituent concentrations appear to decrease downstream of the North Station Street OU1 boundary, with the exception of toluene. While observed toluene concentrations do appear higher and decrease downstream of the upland OU1 boundary, elevated concentrations appear in both upstream and downstream segments indicating there may be external sources resulting in a more widespread distribution of elevated toluene concentrations.

4.4.1.4 Summary of PVOCs in Sediment for all OU2s

- In surface sediments, there were no exceedances of construction worker SLs for PVOCs in any OU2.
- In surface sediments, toluene is the most frequent compound detected above the ecological SL, at 59 samples, compared to 7 samples for total xylene (the next most frequent compound to exceed).
- In subsurface sediments, construction worker exceedances were reported in over 71 samples.
- In subsurface sediments, total xylene, benzene, and ethylbenzene had more observed exceedances than toluene (the opposite of surface sediments).
- In subsurface sediments, 1,2,4-trimethylbenzene and 1,3,5-trimethylbenzene was detected above construction worker SLs in a single sample (WSS-RSB017-001), collected during the B&McD investigation in 2006.
- PVOCs are reported to have a correlation greater than 0.8 with TPAH results, indicating that PVOCs are coincident with TPAHs and decline as PAHs decline (Figure 25).
- Comparisons of individual BTEX compound concentration ranges and medians across the OU2s suggest there are elevated BTEX concentrations within OU2 sediment immediately adjacent to upland OU1 boundaries that decrease downstream of OU1s (Figures 29A through 30C).

4.4.2 Total PAHs in Sediment

Results summarizing TPAH (sum of 13) concentrations in sediment in the Site are presented in Tables 7A and 7B and are summarized below. Results are separated by surface and subsurface observations within each OU2 investigation area. TPAH distribution is presented for each OU2 in Figures 18A through 18C. Box plots of TPAHs reported in each OU2 are presented in Figure 26. TPAHs within surface and subsurface sediment are presented in Figure 27.

As discussed in Section 4.1.1, UTLs developed for the ambient sediment data set for TPAHs and metals are being used to identify samples within the OU2s with analyte concentrations greater than that found in the ambient reach. Discussion of the TPAH UTL exceedances is provided for each OU2 below and summarized in Table L.

Table L. OU2 TPAH Summary

OU2	Sediment Interval	UTL (mg/kg)	Sample Count	TPAHs min (mg/kg)	TPAHs max (mg/kg)	UTL Exceedances Count	Arithmetic mean (mg/kg)	Median (mg/kg)
Willow Street	Surface Sediment (0-1.5 feet below mudline)	342	92	3.631	258	0	67.2	54.6
	Subsurface Sediment (greater than 1.5 feet below mudline)	410	252	0.101	21,510	32	400.98	57.3
Division Street	Surface Sediment (0-1.5 feet below mudline)	342	178	4.4	878	2	43.9	27.6
	Subsurface Sediment (greater than 1.5 feet below mudline)	410	368	0.0034	23,409	18	201	27.3
North Station	Surface Sediment (0-1.5 feet below mudline)	342	65	2.5	538	2	42	11.3
	Subsurface Sediment (greater than 1.5 feet below mudline)	410	144	0.0037	2,334	4	89	10.5

4.4.2.1 Willow Street OU2

A total of 344 sediment samples, including 13 sediment samples collected in 2006 (plus 17 duplicate samples), were analyzed for PAHs.

No surface sediment samples exceeded the calculated UTL in the Willow Street OU2. Maximum TPAHs in surface sediment (257.7 mg/kg) at the Willow Street OU2 were observed at location PCA-22WHS-RVT, on the east side of the channel and downstream of the upland OU, in silt at a depth of 0.5-1.5 feet below mudline.

TPAHs exceeded the UTL in 35 (including 12 samples collected in 2006) of 252 subsurface sediment samples. Maximum TPAH in subsurface sediment at the Willow Street OU2 were observed at location WSS-RSB017, on the east side of the channel adjacent to the upland OU, in silt with odor, at a depth of 8 to 8.5 feet below mudline. Subsurface TPAH UTLs are presented in Figure 18A.

These results indicate surface sediment conditions at the Willow Street OU2 are similar to ambient conditions when compared to the TPAHs UTL, as no exceedances were reported. A number of UTL exceedances are reported within the subsurface sediment adjacent to or downstream of the upland OU1.

4.4.2.2 Division Street OU2

A total of 546 sediment samples (plus 22 duplicates) collected in Division Street OU2 between 2012 and 2013 were analyzed for PAHs.

At the Division Street OU2, TPAHs exceeded the UTL in two samples (STA-3DSS (0.5-1.5) and STA-21DSS-RVT (0-0.5)) of 178 total surface sediment samples, and 19 of 368 subsurface sediment samples.

The maximum TPAH concentration in surface sediment in Division Street OU2 was observed at location STA-3DSS (878 mg/kg), in the center of the channel, upstream of the upland OU and immediately upstream of the Division Street Bridge, in silt at a depth of 0.5 to 1.5 feet below mudline. One other TPAH value, collected

from 21DSS-RVT, exceeds the calculated surface UTL of 342 mg/kg. Both surface UTL exceedances are located upstream of the Division Street upland OU1.

In subsurface sediment, the maximum TPAH concentration was observed at location STA-24DSS (23,409 mg/kg), on the east side of the channel, adjacent to the former MGP, and immediately downstream of the Division Street Bridge, in silt at a depth of 2.5-3.5 feet below mudline. As discussed in Section 4.3.2.2, this location was unique to the area, in that clay was encountered mixed with silt at a depth of only approximately 4.5 feet below mudline, much shallower than was typical for the Site OU2s. In addition, strong odors and oil-wetted sediment were observed at that location and depth. One subsurface exceedance was reported in location ST-72DSS, located upstream of the upland OU1, on the perimeter of OU2. Remaining UTL exceedances were located close to or downstream of the upland OU1. Surface and subsurface TPAH exceedances are presented in Figure 18B.

4.4.2.3 North Station OU2

A total of 209 sediment samples (plus 10 duplicates) collected in North Station OU2 in 2013 were analyzed for PAHs. At the North Station OU2, TPAHs exceeded the UTL in two of 65 surface sediment samples, PCA-1NOS (0.5-1.5) and PCA-6ANOS (0.5-1.5) and five of 144 subsurface sediment samples. These results indicate that surface and subsurface sediment conditions at the OU are largely representative of ambient conditions.

The two highest TPAH concentrations measured in surface sediment were observed at PCA-1NOS, located on the west side of the Canal, near the southern perimeter of OU2, and PCA-6ANOS, located on the east side of the Canal, immediately downstream of the former MGP property and a CSO that runs under Hobbie Street and discharges to the Canal (Figure 6C). The sample from PCA-1NOS was collected in silt and the sample from PCA-6ANOS was collected from coarse grained, black, soft sand. Both samples were collected at a depth of 0.5-1.5 feet below mudline.

Four of 144 subsurface sediment samples exceed the TPAH subsurface UTL of 410 mg/kg. The highest TPAH concentrations in subsurface sediment was observed at location PCA-32NOS MOB, on the east side of the Canal, adjacent to the former MGP property, in silt with oil-coated sand grains, at a depth of 8.5-10.5 feet below mudline. Surface and subsurface TPAH exceedances are presented in Figure 18C.

4.4.2.4 Summary of PAHs in Sediment for all OU2s

- TPAH values versus depth is presented on a scatter plot graph on Figure 28.
- In surface sediments across all three OU2s, 1.0% of samples exceeded the UTL (four of 335 samples), indicating PAH concentrations in OU2 surface sediments are comparable to ambient concentrations.
  - No surface sediment UTL exceedances were reported within Willow Street OU2.
  - Two surface sediment exceedances reported in the Division Street OU were located north of Division Street Bridget (upstream of upland OU1).
  - Two surface sediment exceedances reported in the North Station OU2 were located south of the upland OU1.
- In subsurface sediments of Willow Street and Division Street OU2s, the UTL exceeded in only 8% of the samples (50 of 620 samples), indicating the presence of MGP COPCs above ambient levels at various depths within the subsurface.
- A number of UTL exceedances within Willow Street and Division Street OU2s are located in the vicinity of borings where oil-wetted or oil-coated material was observed (Figure 18A and Figure 18B).
- Subsurface sediments of North Station OU2 had very few exceedances of the UTLs (four of 144 samples) indicating PAH concentrations in subsurface sediments are comparable to ambient concentrations (Figure 18C).

4.4.3 Phenols in Sediment

No exceedances of construction worker SLs were reported for any of the analyzed phenol compounds in surface or subsurface samples from any of the OU2s. Concentrations of phenols did not appear to be correlated with PAH UTL exceedances or observations of MGP residuals within borings. Results summarizing phenol (2,4-dimethylphenol, 2-methylphenol, 3&4-methylphenol, and phenol) concentrations in sediment in the Site are presented in Tables 7A and 7B and summarized below.

A total of 335 surface sediment samples (plus 5 duplicate samples) were analyzed for phenols. No detections above the reporting limit were reported for 2,4-dimethylphenol and 2-methylphenol. Two hundred and thirty-two detections were reported for 3&4-methylphenol, with a maximum concentration of 6.62 mg/kg reported at location PCA-20WHS (0-0.5). The arithmetic mean value for detected 3&4-methylphenol concentrations in surface sediment is 0.512 mg/kg, with the median calculated to be 0.349 mg/kg. Fifty-two samples analyzed for phenol were reported to be above the reporting limit, with a maximum reported value of 6.35 mg/kg (STA-27DSS, 0.5-1.5). The arithmetic mean value for detected phenol concentrations is 0.352 mg/kg, with a median value of 0.128 mg/kg.

Five hundred and sixty-seven subsurface samples (plus 42 duplicate samples) were analyzed for 2,4-dimethylphenol, 2-methylphenol, 3&4-methylphenol, and phenol. Similar to surface samples, there were no results above the reporting limit reported for 2,4-dimethylphenol and 2-methylphenol. There were 251 reported detections for 3&4-methylphenol, with a maximum concentration of 3.62 mg/kg at location PCA-4WHS (9.5-10.5). The arithmetic mean value for detected 3&4-methylphenol concentrations in surface sediment is 0.562 mg/kg, with the median calculated to be 0.417 mg/kg. Fifty-five samples analyzed for phenol were reported to be above the reporting limit, with a maximum detected value of 11.1 mg/kg reported in sample STA-30DSS (11.5-12.5). The arithmetic mean value for detected phenol concentrations is 0.441 mg/kg, with a median value of 0.112 mg/kg.

4.4.3.1 Summary of Phenols in Sediment for all OU2s

No surface or subsurface samples analyzed for phenols in OU2s exceeded applicable construction worker SLs.

4.4.4 Total PCBs in Sediment

PCBs were listed as a COPC for the Willow Street OU2. Total PCB concentrations in sediment samples collected in Willow Street OU2 are presented in Tables 7A and 7B and summarized in Table M and N below. PCB exceedance distribution is presented in Figure 19A (surface sediment) and Figure 19B (subsurface sediment). PCBs were not listed as a COPC in the Division Street or North Station OU2s; therefore, samples collected within those OU2s were not analyzed for PCBs.

Table M. Willow Street OU2 PCB Surface Summary

PCBS	SLs (mg/kg)		Concentration (mg/kg)				Detection Count
	ECO	Construction Worker (CW)	Min	Max	Arithmetic Mean	Median	
Total PCBs	0.0598	1	0.059	67.8	9.61	3.82	92
PCB-1016	NS	NS	NA	NA	NA	NA	0
PCB-1221	NS	NS	NA	NA	NA	NA	0
PCB-1232	NS	NS	NA	NA	NA	NA	0
PCB-1242	NS	NS	0.059	7.21	2.52	2.24	72
PCB-1248	NS	NS	4.55	66.9	29.51	25.6	20
PCB-1254	NS	NS	0.326	3.57	1.04	0.904	72
PCB-1260	NS	NS	0.121	3.32	0.55	0.311	68

ND – Non-detect for all samples submitted
NS – No standard

Table N. Willow Street OU2 PCB Subsurface Summary

PCBS	SLs (mg/kg)		Concentration (mg/kg)				Detection Count
	ECO	Construction Worker (CW)	Min	Max	Arithmetic Mean	Median	
Total PCBs	0.0598	1	0.0329	123	11.35	4.05	126
PCB-1016	NS	NS	NA	NA	NA	NA	0
PCB-1221	NS	NS	NA	NA	NA	NA	0
PCB-1232	NS	NS	NA	NA	NA	NA	0
PCB-1242	NS	NS	0.0438	37.3	2.52	1.09	53
PCB-1248	NS	NS	0.0329	79.9	14.84	5.46	73
PCB-1254	NS	NS	0.0325	32.6	2.06	0.895	76
PCB-1260	NS	NS	0.0377	10.6	0.86	0.4135	74

ND – Non-detect for all samples submitted
NS – No standard

A total of 275 sediment samples (plus 15 duplicates) collected within the Willow Street OU2 were analyzed for PCBs. The range of detected total PCB concentrations in these samples was 0.033 mg/kg to 123 mg/kg.

The highest concentration of total PCBs was located in very soft silt with gravel at PCA-41WHS, from 4.5-5.5 feet below mudline. This sample is located near mid-channel at the upstream end of the upland OU. This boring also contained coal ash, slag, and petroleum- and mothball-like odors. No samples in this boring contained concentration of TPAHs that exceeded the UTL. Ninety-one of the 92 surface sediment samples exceeded both the total PCB ecological benchmark SL of 0.0598 mg/kg and the construction worker selected soil SL of 1 mg/kg. In subsurface sediment, 121 samples exceeded the total PCB ecological benchmark SL and 90 samples construction worker selected soil SL, respectively.

4.4.4.1 Summary of PCBs in Willow Street OU2

- Exceedances were reported within surface and subsurface sediment.
- PCB SL exceedances are consistently observed in surface and subsurface sediments in Willow Street OU2 and do not appear to correlate to TPAH UTL exceedances within Willow Street OU2.
- During the ambient area study in 2011, samples were not analyzed for PCBs and UTLs could not be developed.

4.4.5 Total Metals in Sediment

As discussed in Section 4.1.1, UTLs developed for the ambient sediment data set for TPAHs and metals are being used to identify samples within the OU2s with analyte concentrations greater than that found in the ambient reach. Results summarizing total metal concentrations in sediment in the Site are presented in Tables 7A and 7B, and are summarized below. Results are separated by OU2 investigation areas.

4.4.5.1 Willow Street OU2

Metals were analyzed in a total of 275 samples (plus 15 duplicates). Ranges of detected concentrations of total metals are summarized below and UTL exceedance counts are summarized in Table O below. The distribution of SL exceedances for inorganic constituents is presented in Figures 20A and 20B (for graphical purposes, silver exceedances are not presented on the Figures).

Table O. Willow Street OU2 Metals Summary

Total Metal	Concentration (mg/kg)		UTL Exceedance Value	No. of Ambient UTL Exceedances
	Minimum	Maximum		
Aluminum	1,760	18,000	16,118	6
Antimony	0.17	33.1	13	3
Arsenic	2.8	45.1	30	33
Barium	31.4	669	555	15
Cadmium	0.16	160	133	1
Chromium	16.4	1,840	829	26
Copper	25.5	1,420	1,048	1
Iron	10,300	174,000	71,400	1
Lead	13	2,210	863	51
Manganese	121	810	690	2
Mercury	0.017	152	10	13
Nickel	25.4	323	190	48
Selenium	0.68	17.8	5	5
Silver	0.03	28.8	18	59
Vanadium	0.45	502	70	69
Zinc	37.7	3,540	2,112	54

Exceedances of the UTLs are found throughout the 0U2 at depths ranging from surface to 19.5 feet below mudline. Exceedances of the UTLs were reported in all metal analytes analyzed (Table 7B). The general distribution of metals does not appear to be correlated to the presence of potential MGP residuals, such as NAPL, oil-wetted or –coated sediment, or elevated concentrations of PAHs.

4.4.5.2 Division Street OU2

Metals were analyzed in a total of 442 samples (plus 22 duplicates). Ranges of detected concentrations of total metals and UTL exceedance counts are summarized in Table P below for Division Street OU2. The distribution of SL exceedances for inorganic constituents is presented in Figures 21A and 21B.

Table P. Division Street OU2 Metals Summary

Total Metal	Concentration (mg/kg)		UTL Exceedance Value	No. of Ambient UTL Exceedances
	Minimum	Maximum		
Aluminum	8,550	14,500	16,118	0
Antimony	1.5	5.5	13	0
Arsenic	3.1	118	30	9
Barium	13.4	909	555	11
Cadmium	0.15	212	133	14
Chromium	16.9	7,570	829	33
Copper	19.3	2,470	1,048	1
Iron	16,300	29,300	71,400	0
Lead	13.5	3,360	863	59
Manganese	258	438	690	0
Mercury	0.021	41.4	10	6
Nickel	21.4	330	190	49
Selenium	0.67	5	5	0
Silver	0.067	36.7	18	138
Vanadium	8.4	32	70	0

Maximum concentrations of metals are located throughout the Division Street OU2 at depths ranging from surface to 24.5 feet below mudline. The general distribution of metals does not appear to be correlated to presence of NAPL, oil-wetted or oil–coated sediment, or elevated TPAHs.

4.4.5.3 North Station OU2

Metals were analyzed in 185 samples (plus 10 duplicates). Ranges of detected concentrations of total metals and UTL exceedance counts are summarized in Table Q below for North Station OU2. The distribution of SL exceedances for inorganic constituents is presented in Figures 22A and 22B (for graphical purposes, silver exceedances are not presented on the Figures).

Table Q. North Station OU2 Metals Summary

Total Metal	Concentration (mg/kg)		UTL Exceedance Value	No. of Ambient UTL Exceedances
	Minimum	Maximum		
Aluminum	2,490	30,300	16,118	77
Antimony	0.086	14.3	13	1
Arsenic	2.9	58.6	30	15
Barium	29.5	753	555	4
Cadmium	0.15	182	133	5
Chromium	18.5	2,130	829	18
Copper	25.3	3,700	1,048	2
Iron	7,440	47,500	71,400	0
Lead	13.8	15,300	863	32
Manganese	117	791	690	2
Mercury	0.019	19.7	10	8
Nickel	25.6	246	190	12
Selenium	0.65	5.9	5	3
Silver	0.045	41.5	18	64
Vanadium	2.3	65.3	70	0
Zinc	48.7	3,070	2,112	26

Exceedances of metal UTLs are located throughout North Station OU2 at depths ranging from surface to 19.5 feet below mudline. A few metals (*e.g.,* silver and aluminum) had very high frequencies of UTL exceedances in the subsurface environment. Many of the metals UTL exceedances were very close to the UTL. In subsurface sediments at each OU, many more exceedances of metals UTLs occurred than in surface sediments. The general distribution of metals does not appear to be correlated to presence of potential MGP residuals, such as NAPL, oil-wetted or –coated sediment, or elevated TPAHs. The maximum concentration of only one metal, chromium (PCA-20NOS, 13.5-14.5 feet below mudline), was collocated with TPAHs that exceeded the ambient UTL.

4.4.5.4 Summary of Metals in Sediment for all OU2s

- UTL metal exceedances are observed consistently throughout the OU2s in surface and subsurface sediment.
- Following silver as the highest frequency of UTL exceedances (23% of samples exceeded), aluminum (18% of samples exceeded), vanadium (10% of samples exceeded), and lead (8% of samples exceeded) are reported to have the highest number of exceedances within surface sediment.
- In subsurface samples, following silver as the highest frequency of UTL exceedances (33% of samples exceeded), lead (20% of samples exceeded), aluminum (18% of samples exceeded), and zinc (18% of samples exceeded) are reported to have the highest number of UTL exceedances.
- More exceedances of metals UTLs were observed in subsurface sediments than in surface sediments. The metals UTLs were developed using ambient surface and a limited number of subsurface ambient sediment samples. Discussion of other COPCs in the preceding sections indicates surface and subsurface sediments have different concentration distributions. As a result, the ambient UTLs may not adequately represent ambient conditions for the metals found in the subsurface sediments.
- Metals exceedances in sediments at the OU2s do not correlate with PAH UTL exceedances throughout the OU2s.

- The distribution of metals throughout the OU2s, and lack of correlation with PAH UTL exceedances, indicates metals source is likely from non-MGP related activities taking place on surrounding properties and CSO discharge.

4.4.6 Total Cyanide in Sediment

Results summarizing total cyanide concentrations in sediment in the Site are presented in Tables 7A and 7B and are summarized below. A discussion of results is described for each OU2 in the sections below.

4.4.6.1 Willow Street OU2

A total of 275 sediment samples (plus 15 duplicates) were analyzed for total cyanide at the Willow Street OU2. Results are summarized in Table R below.

Table R. Willow Street OU2 Total Cyanide Summary

Sediment Interval	UTL (mg/kg)	Total min (mg/kg)	Total max (mg/kg)	UTL Exceedances Count	Arithmetic mean (mg/kg)	Median (mg/kg)	Sample Count
Surface Sediment (0-1.5 feet below mudline)	13	0.47	30.4	5	3.12	1.5	92
Subsurface Sediment (greater than 1.5 feet below mudline)	13	0.32	48.4	7	4.10	2.8	183

A total of 12 samples, 5 surface sediment and 7 subsurface sediment, exceeded the ambient UTL of 13 mg/kg. No results exceeded the construction worker selected soil SL value of 4,100 mg/kg. Two hundred and five samples contained total cyanide at a concentration greater than the reporting limit. The range of detected total cyanide in these samples was 0.32 to 48.4 mg/kg, with an arithmetic mean value of 3.75 mg/kg, and a median value of 1.9 mg/kg. The highest concentrations were located at PCA-13WHS, from 4.5 to 5.5 feet below mudline (48.4 mg/kg), and PCA-17WHS, from 0.5 to 1.5 feet below mudline (30.4 mg/kg). These locations are at the east bank adjacent to the upland former MGP facility, and near the mid-channel at the downstream end of the upland former MGP facility, respectively. The highest concentration of total cyanide was located in the same boring with oil-wetted sediment (PCA-13WHS), but at a shallower depth within the sediment column.

4.4.6.2 Division Street OU2

A total of 441 sediment samples (plus 22 duplicate samples) were analyzed for total cyanide at the Division Street OU2. Results are summarized in Table S below.

Table S. Division Street OU2 Total Cyanide Summary

Sediment Interval	UTL (mg/kg)	Total min (mg/kg)	Total max (mg/kg)	UTL Exceedances Count	Arithmetic mean (mg/kg)	Median (mg/kg)	Sample Count
Surface Sediment (0-1.5 feet below mudline)	13	0.54	13.9	2	1.81	1.3	178
Subsurface Sediment (greater than 1.5 feet below mudline)	13	0.14	44.2	9	3.79	2.4	263

Two surface sediment samples and 9 subsurface sediment samples exceeded the ambient UTL of 13 mg/kg. No results were reported to exceed the construction worker selected soil SL value of 4,100 mg/kg. Three hundred and twenty two samples contained total cyanide at a concentration greater than the reporting limit. The range of detected total cyanide in these samples was 0.14 to 44.2 mg/kg, and an arithmetic mean value of 2.85 mg/kg, and a median value of 1.5 mg/kg. The highest concentrations were located at STA-63DSS, from 5.5 to 6.5 feet

below mudline (44.2 mg/kg), STA-75DSS, from 10.5-11.5 feet below mudline (34.8 mg/kg), and STA-60DSS, from 12.5-13.5 feet below mudline (28.4 mg/kg). These locations are in the mid-channel, within approximately 100 feet of the downstream end of the upland former MGP facility, near the east bank adjacent to the upland former MGP facility, and in the mid-channel north of the Division Street Bridge, respectively. The highest concentration of cyanide was located in the same boring with oil-wetted sediment (STA-63DSS), but at a deeper depth within the sediment column.

4.4.6.3 North Station OU2

A total of 185 sediment samples (plus 10 duplicates) were analyzed for total cyanide at the North Station OU2. Results are summarized in Table T below.

Table T. North Station OU2 Total Cyanide Summary

Sediment Interval	UTL (mg/kg)	Total min (mg/kg)	Total max (mg/kg)	UTL Exceedances Count	Arithmetic mean (mg/kg)	Median (mg/kg)	Sample Count
Surface Sediment (0-1.5 feet below mudline)	13	0.2	16.4	2	2.15	1.4	65
Subsurface Sediment (greater than 1.5 feet below mudline)	13	0.3	55.3	10	5.28	3	120

Two surface sediment samples exceed the ambient UTL of 13 mg/kg with a maximum result of 16.4 mg/kg. Ten of the 120 subsurface sample detections were reported to exceed the ambient UTL of 13 mg/kg. No results were reported to exceed the construction worker selected soil SL value of 4,100 mg/kg. One hundred forty-eight contained total cyanide at concentrations greater than the reporting limit. The range of detected total cyanide in these samples was between 0.20 to 55.3 mg/kg, with an arithmetic mean value of 3.93, and a median value of 2.0 mg/kg. The highest concentrations were located at: PCA-21NOS, from 7.5 to 8.5 feet below mudline (55.3 mg/kg), PCA-33NOS, from 4.5 to 5.5 feet below mudline (42.6 mg/kg), and PCA-19NOS, from 8.5 to 9.5 feet below mudline (34.0 mg/kg). These locations are adjacent to the former MGP facility and near the mid-channel, near the east bank, and near the west bank, respectively. In addition to elevated total cyanide, boring PCA-33NOS contained oil-wetted sediment. The elevated cyanide was located in the top of the affected sediment interval.

4.4.6.4 Summary of Total Cyanide for all OU2s

- Total cyanide was found in a limited number of surface sediment samples within the OU2s (9 UTL exceedances reported in 335 samples).
- Similar to surface sediment, total cyanide was found in a limited number of subsurface samples collected within the three OU2s (26 of 556 samples).
- No construction worker exceedances were observed in any of the 901 surface and subsurface samples analyzed for total cyanide.
- None of the total cyanide UTL exceedances were coincident with TPAH UTLs.

4.4.7 TOC in Sediment

Results summarizing TOC concentrations in sediment in the Site are presented in Tables 7A and 7B, and are summarized below. Results are separated by OU2 investigation areas.

4.4.7.1 Willow Street OU2

A total of 274 sediment samples (plus 15 duplicates) were analyzed for TOC at the Willow Street OU2. The range of TOC in these samples was 3.16% to 55.9% (percent was converted by using mg/kg TOC /10,000=% TOC), and the arithmetic mean TOC was 11.6%. The highest concentrations were located at PCA-1WHS, from 0-0.5 feet below mudline (55.9%), PCA-2WHS from 0-0.5 feet below mudline (54.3%), and PCA-5WHS from 0.5-1.5 feet

below mudline (37.6%). Locations PCA-1WHS and PCA-2WHS are in organic silt upstream of the former MGP facility near mid-channel. Location PCA-5WHS is in silt at the west bank, adjacent to the former MGP facility.

The lowest concentrations of TOC were located in lean clay at PCA-1WHS, from 15.5-16.5 feet below mudline (3.16%), in lean clay at PCA-25WHS, from 12.5-13.5 feet below mudline (3.38%), and in lean clay at PCA 13WHS, from 15.5-16.5 feet below mudline (3.47%). These samples were analyzed for PAHs, but not alkylated PAHs. These locations are upstream, adjacent to and downstream of the upland OU1.

Highest concentrations of TOC appear to be located upstream of, or near the upstream end of, the former MGP facility. The lowest concentrations of TOC appear to be located all along the study area at depths greater than 12.5 feet below mudline, at locations that contained no NAPL or oil-wetted or oil–coated sediments; though shallower sediments in core PCA-13WHS contained some of these residuals.

4.4.7.2 Division Street OU2

A total of 433 sediment samples (plus 22 duplicates) were analyzed for TOC at the Division Street OU2. The range of TOC in these samples was 3.3% to 18.5%, and the arithmetic mean TOC was 9.3%. The highest concentrations were located at STA-25ADSS, from 18.5-19.5 feet below mudline (18.5%), STA-75DSS, from 0-0.5 feet below mudline (18.2%), and STA-46DSS, from 12.5-13.5 feet below mudline (17.2%). Sample STA-25ADSS (18.5-19.5 feet below mudline) also contained a concentration of TPAHs that exceeded the UTL (3,494.2 mg/kg); the other samples with maximum TOC did not. These locations are in silt at the east bank adjacent to the former MGP facility, in silt at the east bank farthest upstream, and at the top of lean clay near the east bank adjacent to the former MGP facility, respectively.

The lowest concentrations of TOC were located at STA-44DSS, from 12.5-13.5 feet below mudline (3.3%), STA-41DSS, from 10.5-11.5 feet below mudline (3.6%), and STA-42DSS, from 12.5-13.5 feet below mudline (3.7%). None of these samples contained a concentration of PAHs that exceeded the UTL. All three of these locations are in lean clay at the far downstream end of the sediment study area, downstream of the former MGP facility.

Highest concentrations of TOC appear to be located near the east bank, at varying depths within the sediment column, and at locations where sheen or NAPL were observed. Lowest concentrations of TOC appear to be located at the farthest downstream end of the study area, at depths greater than 10.5 feet below mudline, at locations where sheen or odor were observed, or no affected sediment was observed.

Three samples with a TOC of greater than 15% contained concentrations of TPAHs that exceed the UTL. Organic carbon can act to sequester organic compounds, reduce their bioavailability to benthic organisms, and limit their migration in the system.

4.4.7.3 North Station OU2

A total of 185 sediment samples (plus 10 duplicates) were analyzed for TOC at the North Station OU2. The range of TOC in these samples was 2.42% to 26.7%, and the arithmetic mean concentration was 9.29%. The highest concentrations were located at PCA-27NOS, from 13.5-14.5 feet below mudline (26.7%), PCA-5NOS, from 15.5-16.5 feet below mudline (16.2%), and STA-28NOS, from 13.5-14.5 feet below mudline (15.9%). None of these samples contained a concentration of TPAHs that exceeded the UTL. These locations are in silt and gravel at the west bank upstream of the former MGP facility, in silty clay near the west bank downstream of the former MGP facility, and in silt near the east bank upstream of the former MGP facility, respectively.

The lowest concentrations of TOC were located in sand at PCA-31NOS, from 0.5-1.5 feet below mudline (2.4%), in sand at PCA-6ANOS, from 0-0.5 feet below mudline (2.6%), and in sand at PCA-6ANOS, from 0.5-1.5 feet below mudline (2.7%). The concentration of TPAHs in sample PCA-6ANOS, from 0.5-1.5 feet below mudline, exceeded the UTL. These locations are grouped together at the east bank at the downstream end of the former MGP facility.

The highest concentrations of TOC appear to be in silt and silty clay, located deep in the sediment column throughout the OU. The lowest concentrations of TOC appear to be in sand, in shallow sediment at the

downstream edge of the upland portion of the OU. TOC values are reported to be generally above 10% where TPAHs exceed UTLs.

4.4.8 Black Carbon in Sediment

Results summarizing black carbon concentrations in sediment in the Site are presented in Tables 7A and 7B and are summarized below. Results are separated by OU2 investigation areas.

4.4.8.1 Willow Street OU2

A total of 84 sediment samples were analyzed for black carbon at the Willow Street OU2. The range of black carbon in these samples was 21,500 mg/kg to 102,000 mg/kg, and the arithmetic mean concentration was 38,200 mg/kg.

The highest concentration of black carbon was located in organic silt at PCA-1WHS, from 0-0.5 feet below mudline. This is the same location and depth interval that contained the highest concentrations of TOC, and is located near mid-channel, upstream of the former MGP facility. No samples in this boring contained concentration of TPAHs that exceeded the UTL. The lowest concentration of black carbon was located in lean clay at PCA-8WHS, from 13.5-14.5 feet below mudline. This location is at the west bank adjacent to the former MGP.

Both the highest and lowest concentrations of black carbon are located near the west bank in the upstream half of the study area. Neither sample contained a concentration of TPAHs that exceeded the UTL. Highest concentrations of TOC and black carbon at the Willow Street OU2 were found in the same surface sample.

4.4.8.2 Division Street OU2

A total of 99 sediment samples were analyzed for black carbon at the Division Street OU2. The range of black carbon in these samples was 21,000 mg/kg to 48,800 mg/kg, and the arithmetic mean concentration was 33,963 mg/kg.

The highest concentration was located at STA-32DSS, from 0-0.5 feet below mudline. This location is in silt along the east bank of the River just south of the Boatyard Parcel, and is from the same boring location as two samples that contained a concentration of TPAHs that exceeded the UTL. The samples that exceeded the UTL were in silt at 11.5-12.5 and in lean clay at 12.5-13.5 feet below mudline. The lowest concentration was in silt located at STA-64DSS, from 0-0.5 feet below mudline. This location is also at the east bank at the downstream end of the upland portion of the OU, and is within the same boring as a sample that contained a concentration of TPAHs that exceeded the UTL. The sample that exceeded the UTL was in lean clay at the base of the sediment column (8.5-9.5 feet below mudline), and contained wood debris coated in weathered tar-like material.

Both the highest and lowest concentrations of black carbon are located within surface sediment in the same portion of the study area. Neither sample contained a concentration of TPAHs that exceeded the UTL, but samples deeper within both cores contained concentrations of TPAHs that exceeded the UTL.

4.4.8.3 North Station OU2

A total of 44 sediment samples were analyzed for black carbon at the North Station OU2. The range of black carbon in these samples was 14,400 mg/kg to 41,700 mg/kg, and the arithmetic mean concentration was 32,120 mg/kg.

The highest concentrations were located at PCA-24NOS, from 0-0.5 feet below mudline (41,700 mg/kg). and PCA-10NOS. from 12.5-13.5 feet below mudline (40,400 mg/kg). These locations are in silt near mid-channel at the upstream end of the former MGP property and near the east bank adjacent to the former MGP property, respectively. None of the 44 samples collected contained a concentration of TPAHs that exceeded the UTL. The lowest concentration of black carbon was located at PCA-6NOS, from 0-0.5 feet below mudline. This location is in silt at the east bank at the downstream end of the former MGP facility, immediately downstream of the Hobbie Street CSO.

At the North Station OU2, both the highest and lowest concentrations of black carbon are located within surface sediment, though at opposite ends of the study area. Another sample, PCA-10NOS (12.5-13.5), with a high concentration of black carbon, is deeply buried within the sediment column.

4.4.9 Supplemental Statistical Analysis

As a supplemental statistical analysis, a comparison of the arithmetic mean concentrations of metals, cyanide, and TPAHs in the ambient data set and the OU2 data sets was performed. To perform the statistical comparison, all site data for a given analyte were compared to all ambient data for the same analyte, for a given depth interval (surface or subsurface). A description of the methods used to perform the supplemental statistical evaluation and the results of the evaluation are provided in Appendix E9.

Based on results of the statistical analyses (Tables C-1 and C-2 of Appendix E1), there are four metals (aluminum, iron, nickel, and silver) that have arithmetic mean concentrations within one or more of the OU2s that exceed those in the ambient study area.

At the Willow Street OU2, iron and nickel arithmetic mean concentrations in surface sediments, and aluminum concentrations in subsurface sediments, were statistically elevated above arithmetic mean concentrations in the ambient study area. The metals that are elevated above ambient conditions are common components of scrap metal, such as that processed at the scrap yard currently occupying the upland Willow Street OU, but not major drivers associated with MGP operations.

At the Division Street OU2, only the arithmetic mean silver concentration in surface sediments was statistically elevated above the arithmetic mean concentration in the ambient study area. The silver UTL exceedances are distributed throughout the OU2s and so appear unrelated to the former MGP operations. For example, there was a single TPAH UTL exceedance in surface sediments, whereas there were 41 silver UTL exceedances in surface sediments.

At the North Station OU2, aluminum, iron, and silver arithmetic mean concentrations in surface sediments, and aluminum concentrations in subsurface sediments, were statistically elevated above arithmetic mean concentrations in the ambient study area. Exceedances of the analytes are distributed both upstream of the MGP, adjacent to the MGP, and downstream of the MGP, and so appear unrelated to the former MGP operations. More specifically, for example, there were only two TPAH UTL exceedances in surface sediments, while there were 22 aluminum UTL exceedances in surface sediments.

Considering the spatial distribution of the metals exceedances at all three OU2s, and the statistical assessment presented in Appendix E1, metals appear unrelated to the former MGP operations.

4.4.10 Forensic Characterization in Sediment

To evaluate whether the sediment samples with TPAH UTL exceedances are potentially associated with former MGP operations, forensic characterization of the sediment samples was conducted using the ambient investigation and OU2 site samples. The level of evaluation conducted for this document is analogous to the level of evaluation that was performed in response to USEPA comments on the Site Step I Data Evaluation, Revision 2 (NRT 2013), for the Division Street and Willow Street OUs.

The forensic evaluation was conducted to examine whether there are any apparent differences between the high and low molecular weight (MW) PAHs, and origin of the sources of PAHs (*e.g.*, petrogenic *vs.* pyrogenic) between site-specific and ambient sediment samples. An Excel workbook of the results of this preliminary forensic evaluation for all RI data collected to date, for all three OUs within the Site (North Station, Division, and Willow), and the ambient study area is attached to this document (Appendix E7). In the workbook are figures, tables, and the raw data used for the analysis. In Appendix E7, NOS refers to samples that were collected at North Station, DSS to samples that were collected at Division Street, WHS to samples that were collected at Willow Street, and ACR to samples that were collected in the ambient study area. A summary of the results of the analysis are described below.

Appendix E7, Figure F-1, provides a double ratio plot to evaluate the difference in origin of the source of PAHs on the x-axis, and the difference in the amount of light versus heavy PAHs on the y-axis. These analyses were performed using the sediment samples where data for 34 PAHs were available, because this type of data is required to evaluate the difference between PAH sources. The ratio of the concentration of pyrogenic PAHs over TPAHs in the sample is plotted on the x-axis. The x-axis represents the percent of PAHs in a sample that are pyrogenic in nature. Samples that are further to the left on the plot have a higher percentage of petrogenic PAHs; samples further to the right on the plot have more pyrogenic PAHs. The ratio of the concentration of heavy MW PAHs over TPAHs in the sample is plotted on the y-axis. PAHs with four to six rings are considered heavy, whereas those with two or three rings are considered light. The y-axis represents the percent of PAHs in a sample that are heavy in nature. Samples that are higher up on the plot have a higher percentage of heavier PAHs; samples that are lower on the plot have a higher percentage of lighter PAHs.

Figure F-1 of Appendix E7 illustrates that all but one of the ambient sediment samples have similar PAH characteristics (*i.e.,* they clump together in the same area of the plot). Figure F-1 also illustrates that many of the site sediment samples have similar PAH characteristics and clump together with the ambient samples when plotted. However, there is a group of OU2 sediment samples with PAH characteristics that appear to depart from the ambient sediment samples (samples in blue box on Figure F-1). These site samples generally:

- Have a ratio of heavy MW PAHs less than 0.4, indicating they have more light than heavy MW PAHs than ambient sediment samples.
- Have a pyrogenic ratio that is less than 0.4, indicating these samples have less pyrogenic PAHs than ambient sediment samples.
- Were located at depth and many have relatively high concentrations of TPAHs (samples within the blue box on Figure F-2).

Appendix E7, Table F-1 contains sample results for those samples that were analyzed for 34 PAHs. For the 34-PAH data, the results were then sorted by their heavy PAH ratio. Samples with a heavy PAH ratio less than 0.4 are highlighted as the blue block of samples in the top portion of Table F-1, and represent the site samples that departed from ambient conditions (also shown in the blue box in Figure F-1). For the highlighted samples:

- They are nearly all deep samples, from at least five feet below mudline, and most are from depths greater than 10 feet below mudline (*i.e.*, the average upper depth of the samples in the blue block is over 10 feet [see Table F-1]).
- Some also contain concentrations of TPAHs greater than concentrations in ambient sediment as represented by the UTL (refer to Figure F-2).

The yellow highlighted samples within the blue block of samples on Table F-1 are located in the top few feet of sediment, and all have TPAH concentrations below the UTL.

In Appendix E7, Table F-2, a second analysis was performed for sediment samples for which data for only 16 PAHs were available (*i.e.*, no 34-PAH data). To evaluate what would be an appropriate heavy PAH to TPAH ratio for these sediment samples, for which only 16-PAH data is available, a simple regression analysis was performed. For this regression analysis, the heavy ratios were developed for each investigative sample that has both 34-PAH data and 16-PAH data associated with it. Separate heavy ratios were developed for each sample, using both the total 34-PAH and total 16-PAH concentrations. Then the two heavy PAH ratios were plotted and a regression line fit (see Figure F-3).

Based on the line of regression fit to the two ratios, a heavy PAH to total 16-PAH ratio of approximately 0.6 was found to correspond to the heavy PAH to total 34-PAH ratio of 0.4. The 0.6 heavy PAH to total 16-PAH ratio was used to represent the break point for sediment samples that departed from ambient conditions where only 16-PAH data are available (see the samples highlighted in blue at the top of Table F-2). This analysis with the total 16-PAH data shows comparable results to the analysis performed with the 34-PAH data. For those samples highlighted in the blue block of samples in the top portion of Table F-2:

- They are generally located at depths greater than five feet below mudline (*i.e.*, the average upper depth of the samples in the blue block is over 12 feet [see Table F-2]).
- Some also contain concentrations of TPAHs greater than concentrations in ambient sediment, as represented by the UTL.

The yellow highlighted samples within the blue block of samples are located in the top few feet of sediments and all but one have TPAH concentrations below the UTL (with the exception of sample STA-24DSS, at 2.5-3.5 feet below mudline).

Based on the results of this forensic evaluation, it appears that most surface sediment samples (0-1.5 feet below mudline) at the three sites are similar in nature to ambient sediments, and differ from some of the deep sediment samples that are known to contain MGP residuals. Site sediment samples that appear to have PAH characteristics that depart from the PAH characteristics in ambient sediment samples, and are potentially affected by former MGP operations, generally contain a greater fraction of lighter MW PAHs, are more petrogenic in nature, and are generally located at depths greater than 5 feet below mudline, where potential MGP residuals have been observed. A number of these samples also have TPAH concentrations above the ambient TPAH UTL concentration limits. Table 9 summarizes TPAH results (O'Brien & Gere Engineers, Inc. [OBG] calculated values) exceeding the ambient UTL values and how they were categorized following the ambient investigation.

4.4.11 Benthic Assessments

Results of the Site benthic assessment survey are presented in Table 10 and summarized below. Results are separated by OU2 investigation areas.

4.4.11.1 Willow Street OU2

Two surface sediment samples were collected at Willow Street OU2 during Step I sampling for evaluation of presence/absence of benthic invertebrates, per the SSWP, Revision 2 (NRT 2011b).

- The sample collected at PCA-8WHS was silt with woody debris, and organic material and no NAPL or oil was observed. Worms were observed to be abundant and leeches and freshwater isopods present in less numbers.
- The sample collected at PCA-19WHS was silt with woody debris, organic material, and shell fragments and no indications of NAPL or oil. The Asiatic clam (*Corbicula sp.*) was present in the sample.

4.4.11.2 Division Street OU2

Two surface sediment samples were collected at the Division Street OU2 during Step I sampling for evaluation of presence/absence of benthic invertebrates per the approved SSWP, Revision 1 (B&McD 2009b).

- The sample collected at STA-21DSS was silt with woody debris, organic material and shell fragments and no NAPL or oil was observed. The Asiatic clam (*Corbicula sp.*) was the only organism present at the location.
- The sample collected at STA-30DSS was silt with organic material and indications of NAPL or oil. There were no living organisms observed at the location.

4.4.11.3 North Station OU2

Two surface sediment samples were collected at the North Station OU2 during Step I sampling for evaluation of presence/absence of benthic invertebrates per the approved SSWP, Revision 1 (NRT 2012).

- The surface sample collected at PCA-33NOS was silt with organic material. Oil-wetted, tar-like material, and weathered tar-like pieces were observed at depths between 4.5 and 11.3 feet below mudline. No organisms (*oligochaetes* or *chironomidae*) were observed in the sample.
- The surface sample collected for benthic assessment at PCA-31NOS was silt with organic material. Petroleum-like odors were observed in the core at depths of 7.5-8.5 feet below mudline. *Tuberficidae* were the only organism present in the sample.

4.4.11.4 Summary

- Benthic invertebrates were observed in all three OU2s within surface sediment (Figure 10).
- Concentrations of TPAHs in the ambient area are within the range where sediments are considered toxic to benthic invertebrates (Appendix E1, Enclosure B).
- A report produced for the MWRD reported that the benthic community at two sampling stations along the North Branch River were found to be moderately to highly stressed (EA Engineering, Science and Technology, Inc. 2012).

4.4.12 Geotechnical Testing

Geotechnical testing results for the Site study area are provided in Table 4 and summarized below. Testing was completed in accordance with ASTM D4318, D421, D2974, and D2166, and will be used in the FS. Results are separated by OU2 investigation areas.

4.4.12.1 Willow Street OU2

- Sediments throughout the study area are generally dark gray, dark brown to black organic silt, some sand, and some gravel.
- Sediments have moisture contents from 62.1% to 131.9%, and specific gravities from 2.20 to 2.45.
- Underlying native materials are generally gray organic clay, gray silty clay, dark gray lean clay with some sand and some gravel. Moisture content in the clay ranges from 14.7% to 31.2%, and specific gravity from 2.66 to 2.73.

4.4.12.2 Division Street OU2

- Sediments throughout the study area are generally dark brown to black organic silt, some sand, and some gravel.
- Sediments have moisture contents from 17.8% to 169.4%, and specific gravities from 2.04 to 2.61.
- Underlying native materials are generally gray organic clay, gray silty clay, dark gray lean clay with some fine to medium sand and some gravel. Moisture content in the clay ranges from 15.5% to 18.3%, and specific gravity in one sample of 2.71.

4.4.12.3 North Station OU2

- Sediments throughout the study area are generally dark brown to black organic silt, some sand, some gravel.
- Sediments have moisture contents ranging from 53.7% to 160.3%.
- Underlying native materials are generally dark gray lean clay with some sand and some gravel, with a moisture content of 20.3%.
- One discrete sample of deeply buried sand (16.5-21.5 feet below mudline) was collected at location PCA-30NOS and reported a moisture content of 35%.

4.4.13 Sediment NAPL Mobility Testing

Thirteen undisturbed core samples from 12 locations (sample location ending in -MOB) were collected in 2013 for product mobility analysis. Results are presented in Table 5A and summarized below. Additional details of the analysis and conclusions can be found in the *DNAPL Mobility Evaluation Memorandum* (Exponent 2014), describing the evaluation procedure and results, presented in Appendix E2. The lab report for these samples are included as Appendix E6.

4.4.13.1 Willow Street OU2

Five samples from Willow Street OU2 were collected and analyzed for free-product mobility. These samples appeared to contain some product, in the form of DNAPL, oil-wetted or oil-coated sediment, or weathered tar-like pieces.

Measured in-situ DNAPL saturations ranged from 2.2% to 6.1%. No visible DNAPL was produced during free-product mobility testing.

4.4.13.2 Division Street OU2

Five samples were collected from the Division Street OU. Three of the five samples were run for free-product mobility; the other two samples were run for pore fluid saturation. These samples were reported to contain some product in the form of NAPL, DNAPL, oil-wetted or oil-coated sediment.

Measured in-situ DNAPL saturation ranged from 2.1% to 12.4%. Two of the three samples tested for free-product mobility exhibited a release of DNAPL; each released less than 0.03 milliliters (mL) of DNAPL from specimens containing 0.44 to 4.8 mL.

4.4.13.3 North Station OU2

Three samples were collected from two locations for product mobility testing. One sample was run for free-product mobility (from 8.5-10.2 feet below mudline in core PCA-32NOS), and the other two samples were run for pore fluid saturation. These samples appeared to contain some product, in the form of oil-wetted or oil-coated sediment and weathered tar-like pieces.

No visible NAPL was produced during free product mobility testing (Appendix E2).

4.4.13.4 Summary

Based on Site conditions and laboratory test results, the *DNAPL Mobility Evaluation Memorandum* (Exponent 2014) concludes that free product present in the sediments appears to be immobile under current conditions based on (Appendix E2):

- DNAPLs have limited potential for migration, as they have been observed deeply buried (2.5-19.5 feet or more) by silt in discontinuous thin layers of sediment above the clay.
- Measured DNAPL saturations per unit volume are less than typical residual saturations reported in literature.
- OU2 hydraulic gradients are several orders of magnitude below that which could mobilize DNAPL (Appendix E2).

4.4.14 Stability Assessment

A qualitative approach was taken to assess sediment stability and the potential for remobilization of buried contaminants near the OU2s. The following information was reviewed:

- dredging history/bathymetric analysis; and
- surface water velocity measurements and sediment grain size.

4.4.14.1 Dredging History and Bathymetric Analysis

USACE is responsible for maintaining the navigational channel of the River near the OU2s. Based on USACE, the federally authorized channel on the North Branch presently extends as far north as Addison Avenue. Two different federally authorized channel depths exist for this portion of the River. The River up to North Avenue, has a maintenance depth of 21 feet below the IGLD55 of 577.5 feet (conversions from IGLD to NAVD88 are presented below). The River has not been dredged since 1966. Before that, the USACE performed maintenance dredging every few years as needed (e.*g.*, 1956, 1960, and 1963) to maintain the navigation channel.

Based on USACE, the River channel upstream of North Avenue to Addison Avenue, in the segment adjacent to the Willow Street OU, has a federally authorized channel depth of depth of 9 feet below IGLD55 of 577.5 feet. It is not known when this area was last dredged. As stated in Section 4.3.2.3, the North Branch Canal, where North Station OU2 is located, is not part of the USACE federally authorized channel.

The River is an engineered urban water way with highly controlled flow and limited industrial usage. These types of environments are typically depositional, where the River was historically dredged to the navigational channel. Re-dredging was necessary to remove depositional sediment above the navigational depth, to support

industrial usage of the waterway. As industrial usage declined, re-dredging was not necessary and sediment continued to deposit above the navigational depth over time, or the channel was deauthorized.

Table U, below, summarizes conversions of the vertical datum, first from IGLD55 to the IGLD of 1985 (IGLD85), and then to the NAVD88; NAVD88 is the basis of all project vertical reference going forward. These conversions were made using information from the USACE Coastal Engineering Manual (EM 1110-2-1100) and online conversion tools from the NOAA's National Geodetic Survey. As shown in the table, the dredge maintenance elevation upstream of North Avenue was 568.5 feet (IGLD55), and downstream of North Avenue, within the navigable channel, is 556.5 feet (IGLD55). Willow Street OU2 is located upstream of North Avenue and both Division Street OU2 and North Station OU2 are located downstream of North Avenue.

Table U. Conversions of Vertical Datum, IGLD55 to IGLD85, NAVD88

River Segment	USACE Authorized Channel Depth (feet)	IGLD55 Water Datum Elevation (feet)	IGLD55 Authorized Channel Maintenance Elevation (feet)	IGLD85 Authorized Channel Elevation (feet)	NAVD88 Authorized Channel Elevation (feet)
Upstream of North Avenue	-9	577.5	568.5	569.16	569.71
Downstream of North Avenue	-21	577.5	556.5	557.16	557.51

Datum conversion notes:
IGLD85 = IGLD55 + 0.66 feet
NAVD88 = IGLD85 + 0.55 feet

The following bathymetric surveys were reviewed for this evaluation:

- November, 2008, performed by Ocean Survey, Inc. (OSI), on behalf of USACE. Survey area includes Division Street and North Station OU2s.
- December, 2011, performed by ASE on behalf of PGL. Survey area includes Willow Street and Division Street OU2s.
- January, 2013, performed by ASE on behalf of PGL. Survey area includes North Station OU2.
- April, 2014, performed by ASE on behalf of USACE. Survey area includes all three OU2s.
- November, 2017, performed by USACE. Survey area includes all three OU2s.

The relative sediment elevations between these surveys is compared to assess the changes to sediment elevation over time. USACE authorized channel depth, historical and USACE surveys are presented in Appendix A2, OU2 bathymetric surveys are presented in Appendix C2.

Willow Street OU2

The USACE authorized channel elevation at the Willow Street OU2 is 569.71 feet above mean sea level (NAVD88). The Willow Street OU2 is not included in the November 2008 USACE survey. The first available survey data is from 2011.

Based on bathymetric survey data obtained by ASE of Chicago on December 16, 2011 (see Figure 9A), the River is approximately 200 feet wide at the water surface and 50 to 60 feet wide at the channel bottom near the Willow Street OU. The River bottom elevation varies from approximately 567 to 572 feet above mean sea level (NAVD88) at the shoreline, with relatively gentle slopes of about 8H:1V to 12H:1V toward the bottom. The River bottom elevation ranges from approximately 565 feet at the upstream end of the surveyed area to approximately 561 feet at the downstream end of the surveyed area, at the North Avenue Bridge.

The December, 2011, channel bottom elevations are approximately 4 to 8 feet lower than the USACE authorized channel elevation in this area (569.71 feet).

The April, 2014, and November, 2017, channel bottom elevations are also typically at least 4 feet lower than the USACE historical dredge maintenance depth in this area (569.71 feet).

The elevation where NAPL was observed at the six locations in Willow Street Station are all below the USACE authorized channel elevation as presented in Table 5B.

The sediment elevation in the center of the channel in the Willow Street OU2 is below the USACE authorized channel depth. Dredging history and survey information prior to December, 2011, is not available. Without this information, it is difficult to assess whether the channel was historically dredged below its maintenance depth or if scour has occurred.

A comparison of survey data from 2011 to 2017 indicates that the sediment surface elevations have been consistent between the years, with some deposition occurring and no evidence of significant scour. The fact that USACE dredging in this area was conducted every few years prior to 1966 further suggests a depositional environment in the turning basin and downstream. The channel bottom elevations are considered stable over the recent past and are likely to remain that way into the future, due to the controlled engineered system, unless specifically altered by dredging.

Division Street OU2

Based on the November, 2008, survey data, the sediment elevation is between approximately 559.71 and 568.71 feet above mean sea level (NAVD88). Because the USACE authorized channel depth in this area is 557.5 feet above mean sea level (NAVD88), the sediment elevation in 2008 was at least two feet above the USACE authorized channel depth.

Based on bathymetric survey data obtained by ASE in December, 2011 (Figure 9B), the River is approximately 120 feet wide at the water surface, and 30 to 75 feet wide at the channel bottom in the Division Street Station OU2. The channel bottom elevation varies from approximately 562 to 570 feet above mean sea level (NAVD88), with relatively gentle slopes of about 8H:1V to 12H:1V toward the bottom. The maximum survey elevation identified is approximately 570 feet above mean sea level (NAVD88) in small areas immediately adjacent to the west bank. The River bottom elevation ranges from approximately 560 feet above mean sea level (NAVD88) at the upstream end of the surveyed area to approximately 565 feet above mean sea level (NAVD88) at the downstream end of the surveyed area.

The December, 2011, channel bottom elevations are approximately 2 to 7.5 feet higher than the USACE authorized channel elevation in this area (557.51 feet above mean sea level [NAVD88]).

The April, 2014, and November, 2017. channel bottom elevations are also typically 0 to 2 feet above the USACE authorized channel depth near the downstream end of the OU2, 2 to 4 feet above the historical USACE authorized channel depth in the center of the channel, and more than 4 feet above the USACE authorized channel depth (557.51 feet above mean sea level [NAVD88]) near the shorelines.

The elevation where NAPL was observed at the 29 locations in Division Street Station are all below the USACE authorized channel elevation apart from four locations, STA-1DSS-RVT, STA-54DSS, STA-64DSS, and STA-24DSS (based on bathymetry survey data), as presented in Table 5B and Figure 14B.

Overall, some net deposition has occurred in the Division Street OU2 since it was last dredged in 1966. The channel bottom elevations have been generally consistent since 2008, with some deposition occurring and no evidence of significant scour (surface sediment analytical results similar to the ambient area). The fact that USACE dredging in this area was conducted every few years prior to 1966 further suggests a depositional environment in the turning basin and downstream. The channel bottom elevations are considered stable over the recent past and are likely to remain that way into the future, due to the controlled engineered system, unless specifically altered by dredging.

North Station OU2

Based on the November, 2008, survey data, the sediment elevation in the North Station OU2 is between approximately 563.5 and 568.5 feet above mean sea level (NAVD88). The maximum depth is located immediately downstream of the Halsted Street Bridge. The North Station OU2 is located on the North Branch Canal, which is not part of the USACE authorized channel.

Based on the bathymetric survey data obtained by ASE of Chicago in January, 2013 (see Figure 9C), the Canal is approximately 90 to 100 feet wide at the water surface and 20 to 80 feet wide at the channel bottom near the North Station OU. The channel bottom elevation varies from approximately 562 to 571 feet above mean sea level (NAVD88), with relatively gentle slopes of about 8H:1V to 12H:1V toward the bottom. The maximum survey elevation identified is approximately 575 feet above mean sea level (NAVD88) in small areas immediately adjacent to the east bank. Sediment slopes in these areas approach 4H:1V. The channel bottom elevation ranges from approximately 566 to approximately 564 feet above mean sea level (NAVD88).

The channel bottom elevations have been generally consistent since 2008, with some deposition occurring and no evidence of significant scour. The channel bottom elevations are considered stable over the recent past and are likely to remain that way into the future, due to the controlled engineered system, unless specifically altered by dredging.

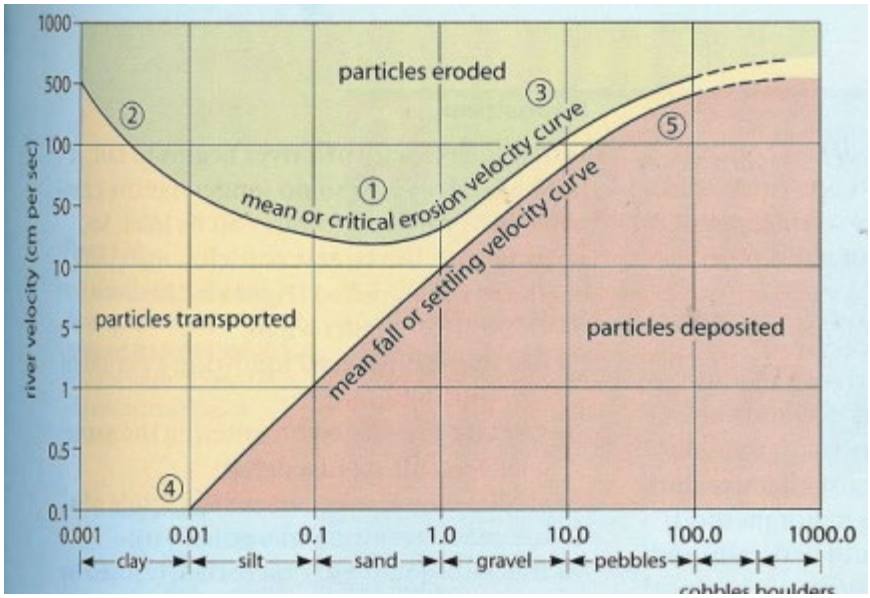
4.4.14.2 Surface Water Velocity and Sediment Grain Size

Water velocity measurements were collected in the Willow Street OU2 between December 11 and 14, 2011, from four locations in, and four locations upstream of, the Willow Street OU, using a digital water velocity meter. The recorded velocity for all eight locations was less than 1 fps, less than the minimum measurable velocity of the equipment.

Water velocity measurements were collected in the Division Street and North Station OU2s between November 12 and 14, 2012, from four locations in, and four locations upstream of, each of the OUs, using a digital water velocity meter. The recorded velocity for all 16 locations was 0 fps.

These low water velocities across the North Branch OU indicate a quiescent environment with low potential for water velocity-driven scour or deposition. Based on the Hjulström curve (Figure A below), a river velocity of at least 20 centimeters per second (cps) (equivalent to 0.7 fps) is required to cause erosion of clay or silt particles.

Figure A. Hjulström Curve



Under normal flow conditions, the River water velocity is unlikely to contribute to significant erosion of the sediment surface near the North Branch OU2s. Flow in the North Branch is highly regulated by MWRD. During storm events, CSO discharge may temporarily increase flow in the North Branch, but MWRD routes that water into the WTPs, TARP, or out to Lake Michigan, as soon as possible, so persistent high flow events with the potential to cause significant scour are unlikely and infrequent.

4.4.14.3 Gas Ebullition

The release of gas bubbles from sediments into overlying water is known as ebullition. Ebullition is generally caused by anaerobic organic decomposition of soft, highly organic material along the River bed. Ebullition is not caused by the former MGP activities, but rather by gas bubbles that come in contact with MGP-affected sediment and can cause the migration of PAHs and other COPCs from subsurface sediment to surface sediment, or the overlying water column. Gas ebullition can also destabilize and transport NAPL present in subsurface sediment to the surface sediment, or overlying water column, creating a sheen on the water surface (Hughes, *et. al.* 2004). Although ebullition was not observed during RI activities in the River, ebullition has been evaluated as a potential pathway for the purposes of this report.

For ebullition to transport NAPL from the subsurface sediment to the surface sediment, or overlying water column, the following three conditions must be met:

1. The sediment must contain NAPL.
2. The sediment must produce gas bubbles.
3. The gas must come into contact with the NAPL.

Condition 1 is present in the Site OU2s. Conditions 2 and 3 may be present and are further evaluated below.

Ebullition was not observed during any of the sediment sampling events performed on the North Branch River or Canal. Ebullition potential is influenced by a variety of factors, including sediment organic content, redox potential, dissolved oxygen, temperature, depth of water, and other factors, and varies from site to site. Ebullition is unlikely to occur in the absence of organic material. Because the average TOC in the North Branch sediments ranges from 9.3% to 11.6% at the three OU2s (Section 4.3.8), organic material is available for ebullition to occur. The analysis presented in this section assumes that even though ebullition has not been observed at the OU2s, it could potentially occur.

Numerous studies have been performed to evaluate the depth at which gas bubbles are produced (Condition 2), including the following references which indicate ebullition originates within the top 1 meter (3.3 feet) of the sediment:

- The Stryker Bay study (van Kessel, *et al*. 2003) states that ebullition is possible when channelization occurs, among other conditions not discussed here. Channelization is when a connected channel of gas forms between the leading edge of water displacement and the gas source. Channelization is generally inhibited below 0.3 m. Also, because NAPL is five times more viscous than porewater, NAPL transport through those channels is generally slow.
- The active ebullition zone is typically the top 1 meter (3.3 feet) (Viana 2012).
- An investigation performed by the University of Illinois-Chicago and MWRD on Bubbly Creek states that "both increased sediment depth and increased whole core organic carbon levels were inversely proportional to gas flux, indicating that biogenic gas ebullition may be localized to upper sediment layers," (Viana 2008) and the upper 1 meter of sediment is the most active zone with the greatest ebullition potential (Viana 2007).
- A study performed by the University of Utah states, "A simple physical model of bottom currents and sediments in these lakes suggests that most methane ebullition originated from the upper 10–20 cm of the sediment column" (Joyce and Jewell 2003).

As described in Section 4.3.2, NAPL was observed in the top 3.3 feet of sediment at two boring locations (PCA-32WHS and STA-24DSS) out of the 187 borings advanced within the three OU2s. Ninety-five percent

(95%) of NAPL observations and 88.5% of TPAH UTL exceedances occur in sediment deeper than 3.3 feet below mudline. Therefore, if ebullition is occurring, it is occurring at a depth where it is unlikely to come in contact with MGP-affected sediment or NAPL, making Condition 3 largely unsatisfied.

If ebullition were destabilizing NAPL or transporting MGP-related PAHs, one or more of the following conditions would be observed:

- NAPL migrating vertically from the sediment to the water column would cause a sheen on the surface water in the absence of disturbance from sampling equipment.
- NAPL would be observed in surface sediment.
- Surface sediment TPAH concentrations in the investigative area would be higher than in the ambient area, especially where oil-wetted/oil-coated sediment was observed.
- Forensic evaluation would identify PAHs from an MGP source in the OU2 surface sediment.

As described in earlier sections, apart from NAPL observations within the top 3.3 feet in two borings, none of these conditions are present in the OU2s, further indicating ebullition is not transporting MGP-affected sediment or NAPL from the subsurface to the surface. These secondary lines of evidence, and the lack of observed ebullition during RI activities, indicate contaminant transport via ebullition is not a primary concern for the FS in the North Branch OU2s.

4.5 SURFACE WATER AND GROUNDWATER TO SURFACE WATER INTERFACE

The following subsections summarize the surface water and upland groundwater sampling results (Tables 8A and 8B).

4.5.1 Groundwater to Surface Water Interface

No sheen on the water surface was observed during collection of surface water samples.

A total of 36 surface water samples were collected during two sampling events completed in 2011 and 2012. The North Station OU2 was only sampled in 2012, following approval of the SSWP, Revision 0 (NRT 2011). Analytical results were compared to the CAWS Human Health and Threshold SL, and Aquatic Life Chronic and Acute SLs and RAF selected ecological SLs (Table 8A).

The CAWSs SLs were used as a more conservative approach than the USEPA-approved multi-site program groundwater SLs, as they were developed to "protect primary contact, incidental contact or non-contact recreational uses (except when designated as non-recreational waters); commercial activity, including navigation and industrial water supply uses; and the highest quality aquatic life and wildlife that is attainable, limited only by the physical condition of these waters and hydrologic modifications to these waters (35 IAC 302)." Sixteen samples were collected within the ambient area and 20 samples collected within the OU2s (two sample rounds completed in Willow Street and Division Street OU2 and one sample round completed in North Station OU2). Cadmium, chromium, copper, lead, nickel, zinc, and manganese have ecological surface water SLs that are hardness dependent. These SLs were adjusted to the average hardness (204 mg/L $CaCO_3$ equivalent) of the River, derived from the RI surface water quality data, as presented in Table 8A.

Twenty-three of 36 surface water samples exceeded the CAWS Human Health and Threshold SL for benzo(a)pyrene across sampling events in 2011 and 2012 (10 of which were located within OU2s and 13 within the ambient area). A summary of average benzo(a)pyrene concentrations of investigative samples in ambient and respective OU2 samples are presented in Table V below.

Table V. Summary of Average Benzo(a)pyrene Concentrations of Investigative Samples

OU	CAWS Human Health and Threshold benzo(a)pyrene SL (micrograms per liter; µg/L)	Ecological SL (µg/L)	2011		2012	
			Ambient Arithmetic Mean (µg/L)	OU2 Arithmetic Mean (µg/L)	Ambient Average (µg/L)	OU2 Arithmetic Mean (µg/L)
Willow Street OU2	0.016	0.014	0.029	0.022	0.017	0.012
Division Street OU2				0.039		0.016
North Station OU2			NA[1]	NA[1]		0.023

[1]Surface water samples were not collected in North Station OU2 during the 2011 Willow Street OU2/Division Street OU2 sediment investigation.

Arithmetic mean benzo(a)pyrene concentrations in surface water were slightly higher in Division Street OU2 samples than ambient samples in 2011, whereas the opposite was observed in the Willow Street OU2. During 2012 sampling, average concentrations in surface water were slightly higher in North Station OU2, whereas the opposite was observed in both the Willow Street and Division Street OU2s.

No other constituents exceeded the Human Health and Threshold SL, or the Aquatic Life Chronic and Acute SLs, in either OU2 sampling events in 2011 or 2012 (Table 8A).

Thirteen of the 20 samples collected within the OU2s exceeded the benzo(a)pyrene ecological SL of 0.014 micrograms per liter (µg/L). Fifteen of 16 ambient samples exceeded the same ecological SL. Five samples, located across the three OU2s, exceeded the benzo(a)anthracene ecological SL of 0.025 µg/L. Two ambient samples were also reported to exceed the benzo(a)anthracene ecological SL, also.

For metals, four samples, collected in the Division Street and North Station OU2s, exceed the aluminum ecological SL of 87 µg/L, along with three ambient samples. A single exceedance of the ecological SL for dissolved lead was reported for SWS-3DIV, and total lead exceedances were reported in one sample collected in each of Division Street, Willow Street, and North Station OU2s (2012 sampling round).

As stated in Section 3.7.8, all samples collected for analysis of inorganics in 2012 were not filtered and were submitted as whole samples for analysis of total inorganic constituents. Analyzing the whole samples is a more conservative approach, as the ecological benchmarks are based on filtered samples. Based on USEPA, the dissolved constituents more closely approximate the bioavailable fraction of a metal in the water column (USEPA 1993). Analytical laboratory reports for all surface water sampling events are included in Appendix F.

4.5.2 Groundwater to Surface Water Interface

As discussed previously, the flow of the groundwater in the three upland OU1s is generally toward the River. Evaluating this groundwater to surface water interface (GSI) is an important consideration when discussing surface water sampling results adjacent to these upland OU1 sites. The *USEPA Decision Matrix for Evaluating Groundwater to Surface Water Interface Pathway at MGP Upland Sites* (GSI Decision Matrix) (Appendix A5) provides a framework for evaluation of GSI using a stepped approach to characterize this pathway between the upland OU1s and adjacent River OU2s.

Per Steps 1 and 2 in the GSI Decision Matrix, groundwater data collected from Willow Street Station, Division Street Station and North Station upland OU1 sites were compared to the CAWS Human Health and Threshold SL, and Aquatic Life Chronic and Acute SLs, and RAF selected ecological SLs, to identify concentrations of COPCs in groundwater that may potentially influence the surface water of the River.

Locations of Willow Street Station, Division Street Station and North Station upland OU1 monitoring wells are presented on Figures 8A, 8B, and 8C. Seasonal samples were collected from these monitoring wells between

2011 and 2019. Analytical data from the sampling events screened against CAWS and RAF selected ecological SLs are tabulated in Table 8B, and results are discussed below by OU2 investigation areas.

Additional discussion of the GSI and implications for the Willow Street Station, Division Street Station and North Station OU1 and OU2 sites are discussed in Section 5.4

Willow Street OU2

Data collected from seasonal groundwater samples collected in 2012 and 2013 show exceedances of PVOCs, PAHs, total lead and cyanide within monitoring wells on the upland OU1 site and adjacent to the River. Of the 18 well locations that were screened, five locations reported seasonal exceedances of CAWS and RAF selected ecological SLs for benzo(a)pyrene and lead. These locations included MW101, MW105, MW107 which are located adjacent to the River. Other observed exceedances at these wells include BTEX (MW107 only), and PAHs.

Division Street OU2

Data collected from seasonal groundwater samples collected in 2011 and 2018 show exceedances of benzene, ethylbenzene, xylenes, PAHs, and metals across the upland OU1 network of monitoring wells. No consistent exceedances of PVOCs, PAHs or metals were reported in samples collected from the two locations closest to the River (MW110 and MW108).

North Station OU2

Data collected from seasonal groundwater samples collected between 2011 and 2019 show exceedances of PVOCs, PAHs and metals across the upland OU1 network of monitoring wells. Exceedances of CAWS and RAF selected ecological SLs were reported for benzo(a)anthracene and benzo(a)pyrene at location NOS-MWP109, located adjacent to the River. No PVOC exceedances were reported at either NOS-MWP109 or NOS-MWP111 (also adjacent to the River). Lead exceedances were also reported in NOS-MWP109.

4.5.3 Summary

- Two rounds of surface water samples were collected in the ambient area and Willow Street and Division Street OU2s.
- One round of surface water samples was collected in the North Station OU2.
- Numerous benzo(a)pyrene exceedances of CAWS and ecological SLs were reported in samples collected within the ambient area and OU2s. No other CAWS exceedances were reported.
- All five OU2 benzo(a)anthracene ecological SL exceedances were collocated with benzo(a)pyrene CAWS exceedances.
- Total aluminum exceedances collected within the ambient area and the OU2s were reported in all samples that were above the reporting limit.
- Three of the four lead ecological SL exceedances were reported in samples analyzed for total lead, a conservative sampling approach.
- Numerous groundwater results exceed CAWS and RAF selected ecological SLs at upland OU1s including monitoring wells adjacent to the River.
- Based on observed groundwater and surface water SL exceedances and in accordance with the GSI Decision Matrix (Appendix A5), further GSI evaluation is warranted and will be completed as part of Willow Street Station, Division Street Station and North Station Upland OU1 assessments.

4.6 RI DATA DELINEATION DISCUSSION

One of the purposes of the RI is to determine the extent of the potential media affected by the former MGP operations. Lateral and vertical extents within the OU2s are summarized below.

4.6.1 Sediment

4.6.1.1 MGP Residuals

- DNAPL and oil-wetted/oil-coated sediment was observed in 38 boring locations within subsurface sediment within the three OU2s. The extent of DNAPL and oil-wetted/oil-coated sediment has been defined upstream and downstream of each OU2 (Figures 14A through 14C).
- Vertical delineation of DNAPL and oil-wetted/oil-coated sediment was also established, based on observations above and below the affected interval in all borings (Figure 10A through 11C and Appendix D4). In addition, the native lean clay that underlies the soft sediment was encountered in all areas of the OU2s. DNAPL and oil-wetted/oil-coated material was not observed greater than 1.5 feet into the top of lean clay in any borings where DNAPL or oil-wetted/oil-coated material was identified (Appendix D4), indicating the lean clay acts as a barrier to vertical DNAPL migration.
- Four locations within the Division Street OU2, STA-1DSS-RVT, STA-54DSS, STA-64DSS, and STA-24DSS are calculated to be above the USACE authorized channel depth as presented in Table 5B and shown on Figure 14B.

4.6.1.2 PVOCs

- PVOC exceedances above ecological and construction worker SLs were reported throughout the OU2s (Figure 15A through 17B).
- Ecological exceedances in the surface sediment are driven by toluene exceedances. Toluene exceedances are also observed in ambient area samples. There were no construction worker exceedances reported in surface sediment.
- Within Willow Street OU2, exceedances in surface sediment were observed upstream, adjacent to the upland OU1, and downstream. Within Division Street OU2, exceedances were reported upstream and on the opposite side of the River from Division Street upland OU1. The four total exceedances reported within the North Station OU2 were all located downstream of the North Station upland OU1 (Figure 15A, 16A, and 17A).
- In subsurface sediments, benzene, ethylbenzene, and total xylene exceedances were observed upstream, adjacent to, and downstream of the upland OU1s (Figure 15B, 16B, and 17B).
- Statistical analysis of BTEX concentration ranges and medians suggests elevated BTEX concentrations are located within the River immediately adjacent to upland OU1 boundaries (Figure 29A through 30C).
- Vertical delineation of PVOCs within sediment was determined by visual and PID readings within the competent clay underlying the sediment.

4.6.1.3 Total PAHs

- Analytical results indicate concentrations of TPAHs at the OU2s were not typically elevated above ambient conditions in the surface sediments. In the four locations where TPAH concentrations in surface sediment exceeded the calculated UTL of 342 mg/kg, a forensic evaluation determined that these samples had a similar chemical makeup as samples collected in the ambient reach area and. therefore, were not likely to be due to MGP activities (Table 9 and Appendix E1). Samples with TPAH values below applicable TPAH UTLs were collected below each of the four reported surface exceedances (Figure 18B and 18C).
- In subsurface sediments, 54 TPAH exceedances (including 12 samples collected in 2006) were reported to be above the UTL of 410 mg/kg. The forensic evaluation of the 42 samples collected between 2011 and 2013 indicated that 40 of these samples were potentially MGP related (Table 9 and Appendix E1).
- TPAH UTL exceedance samples are defined laterally, apart from location PCA-1NOS (Figure 18C), located along the south perimeter of North Station OU2. Forensic evaluation of sample PCA-1NOS (0.5-1.5) indicates that the sample had similar PAH chemical makeup as samples collected in the ambient reach area (Exponent 2014 [Appendix E7]).

- Vertical delineation of TPAH exceedances is defined within each boring with few exceptions. Where TPAH UTL exceedances were reported in the bottom samples of nine borings, secondary lines of evidence from adjacent borings define vertical extent in four of the borings (Table 11). The remaining five borings are located in an area downstream of the Division Street upland OU1. All five borings terminated within the lean clay. Deeper samples or equivalent interval samples, where the UTL exceedance was reported in the bottom sample, were not collected in adjacent samples, due to encountering lean clay at a shallower depth in those borings. However, bottom samples in these adjacent borings did not exceed TPAH UTLs (Figure 18B).

4.6.1.4 Phenols

- No surface or subsurface sediment samples exceeded applicable phenol SLs.

4.6.1.5 Metals and Total Cyanide

- Metals and total cyanide exceedances of ambient UTLs (over 261 and 35, respectively) were reported in surface and subsurface soils throughout all OU2s (Figure 20A through 22B).
- Exceedances are spatially distributed upstream, adjacent to, and downstream of the corresponding upland OU1s.
- A statistical evaluation presented in Appendix E1 concluded that metals and total cyanide appear unrelated to the former MGP operations.
- Results of the ambient sediment investigation indicate that River sediments upstream of the Site, and out of the area of influence of the former MGPs, exhibit a moderate level of toxicity. Data analysis included in the Step I Data Evaluation, Revision 2 (NRT 2013), concluded that observed toxicity of ambient sediments was primarily associated with some metals and, to a lesser extent, TPAHs (Appendix E1).

4.6.1.6 PCBs

- PCBs were listed in the SSWP as a COPC in sediment for Willow Street, only (NRT 2011b).
- Exceedances of ecological and construction worker SLs were reported in numerous samples upstream, adjacent to, and downstream of the upland OU1 (Figure 19A and 19B).
- A similar spatial distribution of PCBs is observed in surface and subsurface sediment.
- Eighty tons of PCB-impacted soil were removed from the AFS Parcel, located north of the upland OU1, indicating a potential source that is not MGP-related.
- PCBs were not analyzed during the ambient study; therefore, no UTLs were calculated.

4.6.2 Surface Water and Groundwater to Surface Water Interface

- Benzo(a)pyrene exceedances of CAWS human health and threshold SL were reported in 13 of the 20 surface water samples collected in the OU2s. This analyte also exceeded its CAWS SL in 15 of 16 samples collected in the ambient area.
- Where benzo(a)anthracene ecological SL exceedances were reported, an exceedance of benzo(a)pyrene SL was also reported indicating a relationship between the two.
- A reduced sample set (six of 20 samples collected within the three OU2s) exceeded the applicable aluminum and/or lead construction worker SLs. Five of the six exceedances were reported in samples collected in 2012, which were analyzed for total metals.
- PCBs, a Willow Street surface water COPC, were not detected above the minimum reporting limit in surface water samples collected within Willow Street OU2.
- Numerous groundwater results exceed CAWS and RAF selected ecological SLs at upland OU1s including monitoring wells adjacent to the River and warrant further evaluation per the GSI Decision Matrix (Appendix A5). Further evaluation will be completed as part of Willow Street Station, Division Street Station and North Station Upland OU1 assessments.

5 FATE AND TRANSPORT

This section discusses the results of the baseline risk assessment (BLRA), the refinement of the CSM, and the fate and transport of MGP-affected River media.

5.1 CONCEPTUAL SITE MODEL

The CSM presents the potential source of impacts, media of concern, potential receptors, and exposure pathways. As discussed in Section 3.2, the preliminary CSMs presented in the SSWPs for Willow Street, Division Street, and North Station were developed based on available historical data and presented in the Completion Report. The preliminary CSMs were used to identify potential data gaps to evaluate in the RI. As additional data became available during the RI, the CSM was updated and refined. The refined-RI CSM is included in the BLRA (Appendix I). A copy of the site specific CSM is included as Figure 23. A graphical presentation of the CSM has also been included as Figures 24A through 24C.

5.2 BASELINE RISK ASSESSMENT

The BLRA for the Site OU2s was performed by Exponent, in conformance with the RAF (Exponent 2007) and subsequent addenda to the RAF, through RAF Addendum, Revision 6, for PGL (Exponent 2017). The RAF addresses both HHRA and ERA (Exponent 2007). RAF addenda were prepared to address changes in human health SL and vapor intrusion (VI) assessment guidelines, because the RAF was developed in 2007. The BLRA is included in Appendix I.

An important aspect of the BLRA is consideration of ambient sediment conditions. Upstream ambient surface water and sediment data, specifically for the River, were collected in early 2011 to establish ambient conditions in the River. Based on the results of an ambient sediment investigation conducted on the River, and a similar study completed in the South Branch of the Chicago River, it was determined that exceedances of the CAWS are unrelated to former MGP operations. In addition, aquatic toxicity testing of the ambient sediments in the River revealed that they were moderately toxic to sensitive ecological receptors (i.e., benthic invertebrates) based on the TPAH and metals concentrations. For this reason, the BLRA for the River includes comparison of surface water and sediment data to the River ambient data, to put into perspective the analyte concentration detected in OU2 sediment and surface water samples.

Also, considering the ambient TPAH sediment concentrations were found to be moderately toxic to benthic invertebrates based on the sediment toxicity testing, other less direct lines of evidence such as toxicity modeling for TPAH was not performed as part of the ERA. However, for analytes that were not elevated in ambient sediment samples (e.g. BTEX), toxicity modeling was performed in the ERA for investigative sediment samples collected in each OU2 area to evaluate whether sediments of the North Branch Chicago River would be potentially toxic to benthic invertebrates.

Exponent prepared a BLRA, using site data collected through December, 2013. Potential risk at the OU2s from site media were evaluated using the following analytical data sets:

- Sediment: Data collected during Step I and Step II sediment investigations completed between 2012 and 2013, and historical data from 2006.
- Surface Water: Data collected in 2011 and 2013.

5.2.1 Media of Concern

The media of concern include:

- Surface sediment (0 to 0.5 feet below mudline)
- Subsurface sediment (greater than 0.5 feet below mudline)
- Surface water within the OU2s

5.2.2 HHRA Receptors and Exposure Pathways

In the BLRA, calculated risks are compared to the acceptable risk management criteria, which is generally concentrations that represent an excess upper-bound lifetime cancer risk of between 10^{-4} and 10^{-6} to an individual, and a noncancer hazard index (HI) of less than or equal to 1. These criteria, which are discussed in more detail in the BLRA, are consistent with USEPA and Illinois EPA guidance. For purposes of the RI Report, an evaluation was performed for each media within each OU2 area to determine if the risks:

- Are below the risk management criteria, and need no further evaluation;
- Are within the risk management criteria and will be evaluated in the FS; or
- Exceed the risk management criteria and will need to be addressed in the FS.

Potential human health receptors and exposure pathways evaluated in the OU2s included:

- Sediment:
  - Construction Worker - a quantitative risk assessment of sediment in each OU2 was performed assuming potential contact with surface sediments from non-intrusive activities (*e.g.*, diving inspections) and all sediment from dredging in the river or construction related to utility repairs, bridge, or sheet pile wall maintenance.
  - Recreational User - a qualitative risk assessment of sediment in each OU2 was performed based on the exposure assessment which determined the water depths in OU2s were too deep (typically greater than 6-7 feet in most areas, and in many areas much deeper) and there is no sediment exposure to recreational users of the River.
- Surface Water:
  - Construction worker – dermal contact and incidental ingestion with surface water during construction and maintenance activities performed, such as diving operations to inspect and construct bridges below the water surface.
  - Recreation user - dermal contact with, and incidental ingestion of, surface water while performing recreational boating (stand up paddle boarding, kayaking, *etc.*).

5.2.2.1 OU2 Human Health Risk Summary

Sediment risks were calculated using site-specific construction worker regional screening levels (RSLs) developed using the EPA's online RSL calculator, considering the sediment conditions in OU2, and using UCLs of the arithmetic mean, as the exposure point concentrations.

- Risks associated with surface sediment exposure were below the risk management criteria for the construction worker scenario within each OU2 (below the cancer risk management range and an HI less than 1).
- Risks associated with subsurface sediment exposure were below the risk management criteria for the construction worker scenario within each OU2 area (below the cancer risk management range and an HI equal to or less than 1). However, in each OU2 area, there are isolated locations where DNAPL is present in subsurface sediment (Figures 14A through 14C) and could result in risks to construction workers above the risk management range, if exposed. Apart from two locations, DNAPL is located greater than 3.3 feet below the mudline. In a majority of the boring locations (33 of 38), DNAPL was observed in the unconsolidated organic silt or the silty clay interface directly on top of lean clay.
- There are specific metals (cadmium and mercury) within all three OU2s, and PCBs, which is in Willow Street OU2 only, in sediments that can bioconcentrate in fish. However, these COPCs in sediment are unrelated to the former MGP activities in OU2. The metals, which are distributed throughout the OU2s and have similar arithmetic mean concentrations to the metals sampled in the ambient area (Appendix E9), indicate that conditions are similar to ambient. The PCB concentrations detected at Willow Street OU2 area appear to be

related to the AFS Parcel, directly north of the upland OU2, where upland PCB remediation was previously completed.

Surface water risks were calculated using the most current tapwater RSLs developed by EPA and summarized in RAF Addendum, Revision 6 (Exponent 2017), and both maximum and arithmetic mean average surface water chemical concentrations as exposure point concentrations.

- Risks associated with surface water exposure were within the risk management criteria (below the cancer risk management range and an HI equal to or less than 1) within each OU2 area, under the conservative assumption that the Chicago River was used as a source of drinking water or used for bathing. However, considering that recreational users and construction workers would only incidentally contact or ingest surface water, the actual exposure and, therefore, risk to both recreational users and construction workers are expected to be below the risk management criteria.
- The surface water risks associated with the ambient area of the River located upstream of OU2 were similar to the surface water risks calculated for each OU2 area. This demonstrates that the former MGPs do not significantly contribute to potential surface water risks.

5.2.3 ERA Receptors and Exposure Pathways

The ERA focuses on addressing potential ecological receptor risks associated with River surface water and sediments. The risks to benthic invertebrates that live in the surface water and surficial sediment of the River have been addressed quantitatively through a conservative screening assessment of the surface water and sediment data. Risks to other ecological receptors (fish and aquatic wildlife) are addressed qualitatively.

Potential ecological receptors and exposure pathways evaluated in the OU2s included:

- Sediment:
  - Benthic invertebrates - a quantitative risk assessment of sediment in each OU2 was performed, based on two sediment intervals:
    - Surface sediments (0 to 0.5 feet) to address sediment exposure to sensitive benthic invertebrates living in the bioactive zone of the River. This scenario represents current conditions.
    - Subsurface sediment (greater than 0.5 feet) to address potential future sediment exposure to benthic invertebrates, under the assumption that these sediments become surface sediments as a result of dredging or construction activities within the River.
  - Fish and aquatic wildlife - a qualitative risk assessment was performed.
- Surface Water:
  - Benthic invertebrate – a quantitative risk assessment of sediment in each OU2 was performed.
  - Fish and aquatic wildlife – a qualitative risk assessment was performed.

5.2.3.1 OU2 Ecological Risk Summary

Surface and subsurface sediments were screened against ecological sediment SLs that were developed to be protective to sensitive benthic invertebrates that live in the top six inches of surface sediments.

- In surface sediment, other than for the occurrence of PCBs in the Willow Street OU2, the concentrations of the other COPCs appear to be related to the ambient conditions of the River, unrelated to the MGP site. PCBs in the Willow Street OU2 were identified as ecological constituents of concern (COCs) in surface sediments within Willow Street OU2. However, PCBs are not associated with MGP activities, as discussed above, and will not inform the remedial footprint. The presence of PCBs will be acknowledged in the FS, as it may affect remedial options (*i.e.*, disposal).
- Subsurface Sediment:

- Willow Street – Thirty-two subsurface sediment samples exceeded ambient concentrations of TPAH in the OU2s. There are also ten subsurface sediment samples estimated to pose a potential ecological concern to benthic invertebrates, due to their BTEX concentrations. In addition, similar to surface sediments, PCB concentrations in the subsurface sediment are at concentrations that would pose an ecological concern; however, PCBs are not associated with MGP activities, as discussed above. The presence of PCBs will be acknowledged in the FS, as it may affect remedial options (*i.e.*, disposal). Considering these results, BTEX and TPAH were identified as ecological COCs within subsurface sediments in Willow Street OU2. In addition, within this area, MGP residuals (i.e., NAPL) have been detected in subsurface sediments in isolated locations, which is a condition that is expected to pose a risk to benthic invertebrates if they are exposed to NAPL in subsurface sediments.
- Division Street – Eighteen subsurface sediment samples exceeded ambient concentrations of TPAH within the OU2. There are also four subsurface sediment samples that were estimated to pose a potential ecological concern to sensitive benthic invertebrates, due to their BTEX concentrations. Considering these results, BTEX and TPAH were identified as ecological COCs within subsurface sediments in this area. In addition, within this area, MGP residuals (i.e., NAPL) have been detected in subsurface sediments in isolated locations, which is a condition that is expected to pose a risk to benthic invertebrates if they are exposed to NAPL in subsurface sediments.
- North Station – Four subsurface sediment samples exceeded ambient concentrations of TPAH within the OU2 area. There are also three subsurface sediment samples estimated to pose a potential ecological concern to benthic invertebrates due to the presence of MGP residuals (i.e., NAPL) at these isolated locations. Considering the presence of NAPL in these samples, BTEX and TPAH were identified as ecological COCs within subsurface sediments in North Station OU2.

5.2.3.2 Surface Water

Surface water samples were screened against ecological surface water SLs obtained from the RAF, as well as the applicable CAWS ecological SL values. Constituents detected above ecological surface water SLs are considered to pose a potential ecological concern and are retained as COPCs for further evaluation in the ERA. When COPCs were identified within OU2 areas, comparisons of OU2 surface water chemical concentrations were made to ambient concentrations to put the potential risk into perspective.

- Benzo(a)anthracene, benzo(a)pyrene, and total aluminum were identified as COPCs within Division Street and North Stations OU2s. Benzo(a)pyrene was identified as the only Willow Street COPC in surface water. These analytes were also identified as COPCs in the ambient area. The concentrations of these COPCs in the OU2 areas were similar to ambient conditions, and so none of these COPCs are considered COCs.
- Within the Division Street OU2 area, lead was identified as an additional COPC in surface water, because of exceedance of its ecological SL. However, when the lead SLs were adjusted for the sample specific hardness of the water sample for which the exceedances occurred, it no longer exceeded the lead surface water SL and so was not estimated to pose a concern.
- Due to the above reasons, the surface-water quality within the OU2s does not pose an exposure concern to aquatic ecological receptors that departs from ambient conditions for the River, and no COCs were identified.

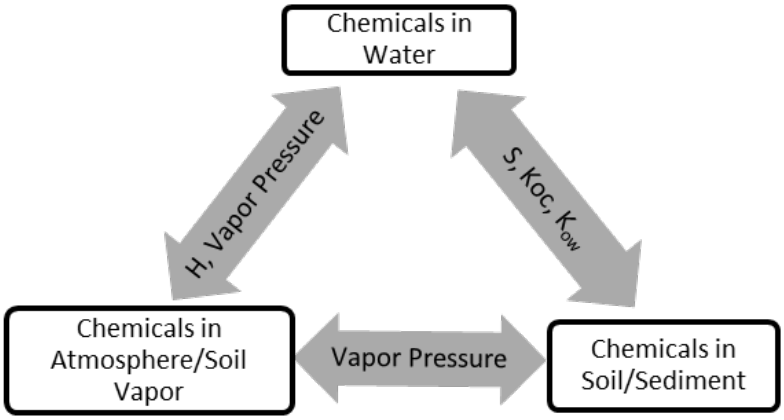
5.3 FATE AND TRANSPORT

The expected fate and transport for the COPCs and COCs identified in Section 5.3.2 within the applicable environmental media are discussed below.

5.3.1 Potential for Migration

The potential for migration depends on the physiochemical characteristics of the chemical (density, water solubility, organic carbon-water partitioning coefficient [K_{OC}], octanol-water partitioning coefficient [K_{OW}], vapor pressure, and Henry's Law constant [HLC]) and the mechanism that releases and moves them through the environment. A description of the physiochemical properties is provided in Appendix J.

Figure B. Physiochemical Parameters



5.3.2 Contaminant Persistence and Site Specific COCs/COPCs

A chemical's persistence in the environment is affected by the following mechanisms: volatilization, sorption, biodegradation, advection, dispersion, and diffusion. These mechanisms are described in Appendix J, along with key characteristics of the COCs and COPCs identified within the BLRA.

5.4 CONTAMINANT MIGRATION

The CSM for Willow Street, Division Street, and North Station OU2s suggests that MGP residuals (DNAPL) potentially released from the upland OU1s to the River OU2s, via gravity along the clay/fill interface and historical piping runs acting as preferential pathways. The upland sources have been identified within the OUs and discussed in other RIs. In addition, as shown in the River DNAPL Mobility Analysis (Exponent 2014, Appendix E2), groundwater hydraulic gradients in wells along the River, at the upland Willow Street OU1 and nearby Division Street OU1, are between four and seven orders of magnitude lower than the gradients necessary to mobilize residual DNAPL.

Additionally, as discussed in Section 4.5.1, affected groundwater at upland OU1 sites may potentially influence surface water via the GSI pathway (Appendix A5). Detailed evaluations of GSI will be included in future assessments for each respective upland OU1 using the GSI Decision Matrix.

As discussed in Section 4.3.2, the MGP residuals observed in the River OU2s are localized and, in a majority of locations, located adjacent to the upland OU1s. When MGP residual was identified, it was generally found at depth, directly above the interface between soft sediment and lean clay. Product mobility testing results (Section 4.4.13) indicate MGP residuals currently located in all OU2s are not considered mobile. Therefore, release likely occurred at some point in the past, when the product was less weathered, or prior to deposition of newer sediment on top of released material.

Within the river environment, there are two main methods for potential contaminant migration to occur: sediment transport via scour, and ebullition.

Review of historical bathymetric data, discussed in Section 4.4.14, and comparison of the USACE survey data between 2007 and 2017, indicates that sediment deposition has occurred since dredging was last completed in 1966, in Division Street and North Station. The River bottom within the Willow Street OU2 is below the USACE navigable channel maintenance depth of 567.71 feet above mean sea level (NAVD88), but without historical information, it is difficult to assess whether the channel was historically dredged below its maintenance depth, or if scour has occurred. Recent comparisons of Willow Street OU2 bathymetry depths between 2011 and 2017 indicate no change in river bottom elevations. Therefore, unless the engineering of the CAWS system is radically changed, or there are future storm events of much greater magnitude than historical events causing scouring of

the river bottom, it is unlikely that the buried MGP residual affected sediment will become exposed to the surface water and potentially transported downstream. As discussed in Sections 4.3.2.1 through 4.3.2.4, there are four, all located within the Division Street Station OU2, of 35 sediment sampling locations where NAPL was observed above the historical USACE authorized channel depths. If USACE were to resume dredging activities in these areas to federally authorized depths, there is potential for these MGP residuals to be exposed to surface water and potentially transported downstream.

Surface water flow velocity measurements were less than 1 fps. Under normal flow conditions, the River water velocity is unlikely to contribute to significant erosion of the sediment surface near the North Branch OU2s. Flow in the North Branch is highly regulated by MWRD. During storm events, CSO discharge may temporarily increase flow in the North Branch, but MWRD routes that water into the WTPs, TARP, or out to Lake Michigan, so persistent high flow events with the potential to cause significant scour are unlikely and infrequent (see Section 4.4.14.2).

Ebullition is a potential contaminant transport pathway that could occur within the River. However, during the RI, ebullition was not observed within the OU2s. As presented in Section 4.4.14.3, a conservative assumption of ebullition depth is 3.3 feet below mudline. If ebullition was occurring within the River, MGP residuals were only observed within the top 3.3 feet in two of 38 borings (PCA-32WHS and STA-24DSS); therefore, it is unlikely that MGP residuals would be mobilized through the movement of gas bubbles.

These lines of evidence indicate that the potential for migration of MGP residuals in the OU2s is minimal.

6 SUMMARY

The results of the RI met the objectives of the Willow Street SSWP, Revision 2 (NRT 2011b), Division Street SSWP, Revision 1 (B&McD 2009b), and North Station SSWP, Revision 0 (NRT 2011), along with the Revision 1 (NRT 2012), and provide adequate information to assess the nature and extent of affected media to support the BLRA and the FS.

6.1 MGP RESIDUALS

Source material is found as oil-wetted or oil-coated material within the subsurface sediment in 38 boring locations, between 2.5 and 21.6 feet below the mudline. DNAPL is observed in the surficial unconsolidated organic silt or the silty clay interface directly on top of lean clay in a majority of locations. The lateral extent of DNAPL is defined upstream and downstream in each OU2 by observations in surrounding locations (Figures 14A through 14C). Vertical delineation was also achieved by observations within borings where DNAPL was encountered at the native lean clay, which acts as a barrier to vertical DNAPL migration (Figures 10A through 12C). Of the 35 locations within the USACE authorized channel (North Branch Canal, where North Station OU2 is located, is not part of the USACE authorized channel), four locations, STA-1DSS-RVT, STA-54DSS, STA-64DSS, and STA-24DSS all located within the Division Street Station OU2, are located above the USACE authorized channel depth (Table 5B and Figure 14B).

In addition, DNAPL mobility testing concluded DNAPL is immobile under current conditions, based on the following (Appendix E2):

- DNAPL has been observed discontinuously in thin layers above the clay and is overlain by multiple feet (2.5 to 18 feet) of silty sediment, limiting potential migration.
- Measured DNAPL saturations in the 13 samples collected were less than typical residual saturations reported in literature.
- Only small percentages of DNAPL were shown to mobilize (2 of 13 samples).
- Site hydraulic gradients are several orders of magnitude below the values at which residual DNAPL could be mobilized.

6.2 SEDIMENT

The following COCs were identified within sediment:

- The BLRA identified BTEX as ecological COCs, if subsurface sediments were exposed in localized areas of Willow Street, Division Street and North Station OU2s (Figures 15B and 16B). These COC locations are either co-located or adjacent to locations with TPAH UTL exceedances.
- TPAH UTL exceedances in subsurface samples in Willow Street, Division Street, and North Station were identified as COCs to ecological receptors under the hypothetical scenario of exposing subsurface sediments in localized areas. Vertical and lateral delineation has been defined based on:
  - Samples collected above and below the reported exceedance
  - Secondary lines of evidence from surrounding borings
  - Encountering the underlying lean clay
- Within the Willow Street OU2, the BLRA identified PCBs as an ecological COC in surface and subsurface sediment; however, PCBs are not associated with MGP activities. The presence of PCBs will be acknowledged in the FS, and PCBs co-located with TPAH or BTEX COCs will be addressed as they may affect remedial options (*i.e.*, disposal).

6.3 SURFACE WATER AND GROUNDWATER TO SURFACE WATER INTERFACE

- No COCs were identified in surface water.
- Groundwater exceedances of CAWS and RAF ecological SLs were reported in the upland OU1s. GSI will be evaluated in more detail in accordance with the USEPA GSI Decision Matrix as part of the upland OU1 assessments.

7 CONCLUSIONS

7.1 DATA LIMITATIONS

Work completed to date is sufficient to support the HHRA and ERA in the BLRA. Sample data density and coverage are sufficient to characterize potential MGP residuals, PAHs, PVOCs, and metals in surface water and sediment within the North Branch River OU2s. Surface water and sediment has been adequately characterized and delineated. Potential current and hypothetical receptors have been identified and discussed in the BLRA. Migration pathways have been identified.

7.2 RECOMMENDATION FOR FUTURE WORK

Sufficient data have been collected to support preparation of the BLRA, FS, and remedy selection. Additional sampling, if necessary, will be identified as part of a Pre-Design Work Plan.

8 PRELIMINARY REMEDIAL ACTION OBJECTIVES

Preliminary Remedial Action Objectives (RAO) will be developed in the FS for the media of concern (sediment) and receptors identified. The FS RAOs will be developed to protect public health, welfare, and/or the environment from site contaminants that may pose an unacceptable risk and will be protective of future uses, as appropriate.

Following USEPA's approval of the RI Report, an Alternatives Screening Technical Memorandum and FS will be prepared to identify potential remedial options to address OU2 risks. Remedial options to be evaluated will include:

- Monitored Natural Recovery
- Dredging
- Capping

These remedial options may be combined and/or may include variations (*i.e.*, targeted dredging versus dredging to allow for cap placement, amended caps versus engineered caps).

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Tables

(Tables 2, 6, 7, 8 Provided Separately)

Table 1 - Summary of Poling Data

Remedial Investigation Report Rev. 1
The Peoples Gas Light and Coke Company
Willow Street, Division Street and North Station Operable Units 2 (River)
The North Branch Site, Cook County, Chicago, IL
USEPA ID: ILD982074759 (Willow), ILD982074783 (Division) and ILD982074775 (North Station)

Operable Unit 2	Station Name	Water Depth (feet)	Poling Refusal (feet below mudline)[1]	Impact Observations
Willow Street	WHS-PCA1	11.6	2.2	Faint visible sheen
Willow Street	WHS-PCA2	12.8	4.5	None
Willow Street	WHS-PCA3	6.7	7.5	None
Willow Street	WHS-PCA4	10.25	5.5	None
Willow Street	WHS-PCA5	7.4	3.7	None
Willow Street	WHS-PCA6	11.1	4.5	None
Willow Street	WHS-PCA7	8.75	1.0	None
Willow Street	WHS-PCA8	6.4	6.6	Faint visible sheen
Willow Street	WHS-PCA9	11.25	0.5	None
Willow Street	WHS-PCA10	9.1	0.6	None
Willow Street	WHS-PCA11	9.4	4.0	None
Willow Street	WHS-PCA12	12.9	3.5	None
Willow Street	WHS-PCA13	8.9	0.2	None
Willow Street	WHS-PCA14	10.7	5.0	None
Willow Street	WHS-PCA15	9.8	2.0	None
Willow Street	WHS-PCA16	7.5	7.1	None
Willow Street	WHS-PCA17	13.0	0.0	None
Willow Street	WHS-PCA18	8.7	1.3	None
Willow Street	WHS-PCA19	9.0	2.0	None
Willow Street	WHS-PCA20	11.3	4.5	Faint visible sheen
Willow Street	WHS-PCA21	12.1	3.6	Faint visible sheen
Willow Street	WHS-PCA22	15.0	5.4	Faint visible sheen
Willow Street	WHS-PCA23	7.3	2.8	None
Willow Street	WHS-PCA24	9.6	5.7	None
Division Street	DIV-PCA1	5.7	6.7	Faint visible sheen
Division Street	DIV-PCA2	12.3	5.2	None
Division Street	DIV-PCA3	17.1	5.7	Faint visible sheen
Division Street	DIV-PCA4	8.0	5.0	None
Division Street	DIV-PCA5	11.7	5.3	Faint visible sheen
Division Street	DIV-PCA6	11.3	3.2	Faint visible sheen
Division Street	DIV-PCA7	11.5	4.0	Faint visible sheen
Division Street	DIV-PCA8	14.2	4.1	None
Division Street	DIV-PCA9	13.1	2.8	None
Division Street	DIV-PCA10	12.7	5.8	None
Division Street	DIV-PCA11	17.2	>5.0	None
Division Street	DIV-PCA12	17.3	>4.0	None
Division Street	DIV-PCA13	17.8	0.3	None
Division Street	DIV-PCA14	6.2	0.0	None
Division Street	DIV-PCA15	6.4	0.0	None
Division Street	DIV-PCA16	15.8	>7.5	None
Division Street	DIV-PCA17	10.3	5.0	None
Division Street	DIV-PCA18	12.0	6.3	None
Division Street	DIV-PCA19	9.3	2.1	None
Division Street	DIV-PCA20	14.0	3.2	None
Division Street	DIV-PCA21	13.8	6.4	Faint visible sheen
Division Street	DIV-PCA22	6.5	6.5	Faint visible sheen
Division Street	DIV-PCA23	17.8	0.0	None
Division Street	DIV-PCA24	15.5	2.4	None
Division Street	DIV-PCA25	4.5	6.5	None
Division Street	DIV-PCA26	7.6	7.2	None
Division Street	DIV-PCA27	14.9	4.4	None
Division Street	DIV-PCA28	14.3	5.3	None
Division Street	DIV-PCA29	16.7	>5.0	None
Division Street	DIV-PCA30	12.7	5.3	None
Division Street	DIV-PCA31	18.7	3.7	None

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Operable Unit 2	Station Name	Water Depth (feet)	Poling Refusal (feet below mudline)[1]	Impact Observations
Division Street	DIV-PCA32	15.3	1.6	None
Division Street	DIV-PCA33	14.4	4.8	Faint visible sheen
Division Street	DIV-PCA34	13.3	5.5	None
Division Street	DIV-PCA35	16.3	5.5	None
Division Street	DIV-PCA36	10.2	5.3	Faint visible sheen
Division Street	DIV-PCA37	14.5	7.2	None
Division Street	DIV-PCA38	15.6	4.2	Faint visible sheen
Division Street	DIV-PCA39	11.5	5.3	None
Division Street	DIV-PCA40	13.8	6.3	None
North Station	PCA-1NOS	8.9	7.3	None
North Station	PCA-2NOS	11.8	8.3	None
North Station	PCA-3NOS	10.7	1.0	None
North Station	PCA-4NOS	12.0	8.0	None
North Station	PCA-5NOS	8.5	0.0	None
North Station	PCA-5NOS_15SE	13.2	10.8	None
North Station	PCA-6NOS	11.5	7.2	None
North Station	PCA-7NOS	11.9	9.5	None
North Station	PCA-8NOS	11.9	11.6	None
North Station	PCA-9NOS	10.6	7.3	None
North Station	PCA-10NOS	7.8	8.2	None
North Station	PCA-11NOS	10.2	5.4	None
North Station	PCA-12NOS	10.7	10.3	None
North Station	PCA-13NOS	10.6	5.1	None
North Station	PCA-14NOS	11.1	5.7	None
North Station	PCA-15NOS	13.6	0.0	None
North Station	PCA-16NOS	13.8	0.0	None
North Station	PCA-17NOS	6.9	1.1	None
North Station	PCA-18NOS	13.4	9.4	None
North Station	PCA-19NOS	10.2	10.9	None
North Station	PCA-20NOS	8.5	9.5	None
North Station	PCA-21NOS	10.3	10.5	None
North Station	PCA-22NOS	10.0	10.8	None
North Station	PCA-23NOS	9.7	10.8	None
North Station	PCA-24NOS	9.2	11.4	None
North Station	PCA-25NOS	9.1	9.1	None
North Station	PCA-26NOS	7.3	10.9	None
North Station	PCA-27NOS	9.6	8.8	None
North Station	PCA-28NOS	7.2	11.0	None
North Station	PCA-29NOS	10.3	10.7	None
North Station	PCA-30NOS	7.1	11.1	None
North Station	PCA-31NOS	10.3	4.3	None
North Station	PCA-32NOS	9.5	2.4	None
North Station	PCA-33NOS	10.8	7.7	None

Note:

1. Measurements listed with a greater than symbol indicate that the depth of water was too great and field team did not have enough poling rod to push rod to depth of refusal.

Table 3 - Sediment Samples Retrieved from Archive

Remedial Investigation Report Rev. 1
The Peoples Gas Light and Coke Company
Willow Street, Division Street and North Station Operable Units 2 (River)
The North Branch Site, Cook County, Chicago, IL
USEPA ID: ILD982074759 (Willow), ILD982074783 (Division) and ILD982074775 (North Station)

Operable Unit 2	Station Name	Depth Interval (feet below mudline)	Sample ID
Willow Street	PCA-32WHS	3.5-4.5	100213170
Willow Street	PCA-32WHS	4.5-5.5	100213171
Willow Street	PCA-32WHS	6.5-7.5	100213173
Willow Street	PCA-32WHS	7.5-8.5	100213174
Willow Street	PCA-37 WHS	7.5-8.5	100213189
Willow Street	PCA-37 WHS	8.5-9.5	100213190
Willow Street	PCA-37 WHS	10.5-11.5	100213192
Willow Street	PCA-24 WHS RVT	10.5-11.5	100213206
Willow Street	PCA-24 WHS RVT	11.5-12.5	100213207
Willow Street	PCA-24 WHS RVT	12.5-13.5	100213208
Willow Street	PCA-15WHS	2.5-3.5	102913311
Willow Street	PCA-15WHS	3.5-4.5	102913312
Willow Street	PCA-22WHS	9.5-10.5	110113385
Willow Street	PCA-22WHS	11.5-12.5	110113387
Willow Street	PCA-29WHS	7.5-8.5	110413439
Willow Street	PCA-29WHS	8.5-9.5	110413440
Willow Street	PCA-29WHS	10.5-11.5	110413442
Willow Street	PCA-30WHS	7.5-8.5	110413453
Willow Street	PCA-30WHS	8.5-9.5	110413454
Willow Street	PCA-30WHS	9.5-10.5	110413455
Willow Street	PCA-30WHS	10.5-11.5	110413456
Willow Street	PCA-44WHS	6.5-8.5	110713492
Willow Street	PCA-44WHS	10.5-11.5	110713494
Division Street	STA-19DSS	10.5-11.5	082613013
Division Street	STA-19DSS	11.5-12.5	082613014
Division Street	STA-23DSS	6.5-7.5	083013157
Division Street	STA-23DSS	7.5-8.5	083013158
Division Street	STA-45DSS	4.5-5.5	083013172
Division Street	STA-45DSS	5.5-6.5	083013173
Division Street	STA-25A DSS	16.5-17.5	090313199
Division Street	STA-25A DSS	17.5-18.5	090313200
Division Street	STA-25A DSS	19.5-20.5	090313202
Division Street	STA-25A DSS	20.5-21.5	090313203
Division Street	STA-25A DSS	22.5-23.5	090313205
Division Street	STA-25A DSS	23.5-24.5	090313206
Division Street	STA-69DSS	9.5-10.5	090513262
Division Street	STA-64 DSS	6.5-7.5	091213516
Division Street	STA-64 DSS	7.5-8.5	091213517
Division Street	STA-81DSS	11.5-12.5	091713627
Division Street	STA-81DSS	12.5-13.5	091713628
Division Street	STA-46DSS	10.5-11.5	091913728
Division Street	STA-46DSS	11.5-12.5	091913729
Division Street	STA-75DSS	9.5-10.5	092313771
North Station	PCA-4NOS	5.5-6.5	111913285
North Station	PCA-4NOS	6.5-7.5	111913286
North Station	PCA-21NOS	11.5-12.5	112013322
North Station	PCA-21NOS	12.5-13.5	112013323
North Station	PCA-19 NOS	9.5-10.5	112013341
North Station	PCA-19 NOS	10.5-11.5	112013342
North Station	PCA-31NOS	7.5-8.5	112013353
North Station	PCA-31NOS	8.5-9.5	112013354
North Station	PCA-5NOS	5.5-6.5	112113372
North Station	PCA-5NOS	6.5-7.5	112113373
North Station	PCA-15NOS	4.5-5.5	112513478
North Station	PCA-15NOS	5.5-6.5	112513479
North Station	PCA-20NOS	8.5-9.5	120313597
North Station	PCA-20NOS	9.5-10.5	120313598
North Station	PCA-20 NOS	11.5-12.5	120313600
North Station	PCA-20 NOS	12.5-13.5	120313601
North Station	PCA-18NOS	7.5-8.5	120413625
North Station	PCA-18NOS	8.5-9.5	120413626
North Station	PCA-17ANOS	8.5-9.5	120413639
North Station	PCA-17ANOS	9.5-10.5	120413640
North Station	PCA-6ANOS	6.5-7.5	120413647

Operable Unit 2	Number of Samples
Willow Street	23
Division Street	20
North Station	21
Total	64

Table 4 - Step I and Step II Sediment Geotechnical Data

Remedial Investigation Report Rev. 1
The Peoples Gas Light and Coke Company
Willow Street, Division Street and North Station Operable Units 2 (River)
The North Branch Site, Cook County, Chicago, IL
USEPA ID: ILD982074759 (Willow), ILD982074783 (Division) and ILD982074775 (North Station)

Operable Unit ARA	Depth Range	Station Cores in Composite	Sample ID	Sample Description	Natural Moisture (%)	Atterberg Limits			Organic Content (%)	Specific Gravity	Coefficients									P100 Content (%)	P200 Content (%)	Unconfined Compressive Strength (psf)	USCS	Data Date
						Liquid Limit (%)	Plastic Limit (%)	PI			D90	D85	D60	D50	D30	D15	D10	CU	CC					
Willow ARA	NORTH 0-4 ft	WHS 2, 3, 7, 8, 12	021412989	Dark Brown to Black Organic Sandy Silt, Little Gravel	90.6	NP	NP	NP	20.2	2.40	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	51.4	NA	NA	NA
	NORTH 4-10 ft	WHS 2, 3, 7, 8, 10, 12	021412990	Dark Brown to Black Organic Sandy Silt, Little Gravel	84.8	39	38	1	19.9	2.45	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	48.0	NA	NA	NA
	NORTH 10 ft-Native	WHS 2, 3, 8, 10, 12	021412991	Dark Brown to Black Organic Sandy Silt, Little Gravel	86.3	57	51	5	19.9	2.39	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	57.3	NA	NA	NA
	SOUTH 0-4 ft	WHS 14, 18, 19, 20, 23	021412992	Dark Brown to Black Organic Sandy Silt, Little Gravel	131.9	NP	NP	NP	20.1	2.26	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	52.7	NA	NA	NA
	SOUTH 4-10 ft	WHS 14, 18, 19, 20, 23	021412993	Dark Brown to Black Organic Sandy Silt, Little Gravel	102.6	NP	NP	NP	23.6	2.23	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	50.1	NA	NA	NA
	SOUTH 10 ft-Native	WHS 14, 18, 19, 20, 23	021412994	Dark Brown to Black Organic Silt, Some Sand, Trace Gravel	95.2	57	54	3	21.0	2.29	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	70.3	NA	NA	NA
	WHS TILL	WHS 2, 18, 7, 12, 23	021412995	Gray Organic Clay, Trace Gravel	24.3	34	20	14	8.1	2.66	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	76.5	NA	NA	NA
	3.5-8.5	PCA-37 WHS	100313254	Brown Fine to Coarse Sand, Some Gravel, Trace Silt and Clay	16.2	NV	NP	NP	2.1	NA	7.0588	4.4843	1.4406	0.9666	0.4228	0.2157	0.1778	8.1	0.7	6.2	NA	NA	SP	10/21/2013
	25.5-27.5	Geo7/PCA-46WHS Shelby Tube	103013372	Dark Gray Lean Clay, Some Sand, Trace Gravel	17.9	26	18	8	1.6	2.70	1.4469	0.5046	0.0185	0.0091	0.002	NA	NA	NA	NA	NA	73.6	2479	CL	10/30/2013
	4.5-6.5	Geo8/PCA-47WHS Shelby Tube	110513476	Black Sandy Organic Silt, Trace Gravel	117.9	NV	NP	NP	15.3	2.20	0.3195	0.2332	0.0898	0.0617	0.021	0.0069	0.0034	26.13	1.43	75	NA	186	ML	11/5/2013
	22-24	Geo8/PCA-47WHS Shelby Tube	110513486	Dark Gray Lean Clay, Some Sand, Trace Gravel	14.7	25	17	8	1.5	2.70	1.3	0.5301	0.0255	0.0122	0.0031	NA	NA	NA	NA	75.7	71.3	6685	CL	11/5/2013
	29.5-31.0	Geo8/PCA-47WHS Shelby Tube	110513489	Dark Gray Lean Clay, Some Sand, Trace Gravel	15.0	26	18	8	1.5	2.73	1.7441	0.7039	0.0328	0.0143	0.0035	NA	NA	NA	NA	73.7	69.4	5581	CL	11/5/2013
	8.5-10.5	Geo 5/PCA-44 WHS Shelby tube	110713493	Dark Gray Organic Clay, Some Sand, Trace Gravel	31.2	36	24	112	9.7	2.69	0.373	0.2171	0.015	0.0082	0.0022	NA	NA	NA	NA	81.2	76.5	498	OL	11/7/2013
	10.5-11.5	Geo6/PCA-45WHS	110813499	Dark Gray Lean Clay, Some Sand, Little Gravel	19.3	29	19	10	1.6	NA	1.748	0.6728	0.0138	0.0068	NA	NA	NA	NA	NA	75.5	72.0	NA	CL	11/8/2013
	12.5-16.5	PCA-27WHS																						
	17.5-18.5	PCA-11WHS																						
	22-38.5	PCA-36WHS																						
	17.5-18.5	PCA-22WHS-RVT																						
	15.5-16.5	PCA-16AWHS-RVT																						
	14.5-15.5	PCA-17WHS																						
	2.5-6.5	PCA-11WHS	110813500	Black Sandy Organic Silt, Trace Gravel	94.1	NV	NP	NP	11.0	NA	0.5618	0.4185	0.0751	0.0533	0.0297	0.0088	0.0033	22.54	3.52	70	60.0	NA	OL	11/8/2013
	5.5-8.5	PCA-17WHS																						
	9.5-14.5	PCA-36WHS																						
	9.5-12.5	PCA-22WHS-RVT																						
	13.5-14.5	PCA-22WHS-RVT																						
	11.5-12.5	PCA-11WHSRVT	110813501	Dark Gray Organic Silt, Some Sand, Trace Gravel	62.1	NV	NP	NP	8.2	NA	0.2426	0.1463	0.0498	0.0251	0.0068	NA	NA	NA	NA	85.3	NA	NA	OL	11/8/2013
	11.5-13.5	PCA-16WHSRVT																						
Division Street ARA	NORTH 0-4 ft	DSS 22, 24, 27, 9, 28	021412996	Dark Brown to Black Organic Sandy Silt	169.4	56	45	11	19.0	2.30	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	78.1	NA	NA	NA
	NORTH 4-8 ft	DSS 22, 2, 4, 27	021412998	Dark Brown to Black Organic Silt, Little Sand, Trace Gravel	134.5	60	51	9	20.2	2.37	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	93.4	NA	NA	NA
	NORTH 8 ft-Native	DSS 22, 2, 4, 27	021412002	Dark Brown to Black Organic Silt, Some Sand, Trace Gravel	107.9	NP	NP	NP	20.2	2.36	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	85.9	NA	NA	NA
	CENTRAL 4-8 ft	DSS 9, 12, 32, 28	021412999	Dark Brown to Black Organic Silt, Some Sand, Trace Gravel	113.4	54	43	11	18.3	2.39	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	82.0	NA	NA	NA
	CENTRAL 8 ft-Native	DSS 9, 32, 28	021412003	Dark Brown to Black Organic Silt, Some Sand, Trace Gravel	100.9	58	52	6	20.8	2.31	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	83.5	NA	NA	NA
	SOUTH 0-4 ft	DSS 39, 15, 34, 12, 32	021412997	Dark Brown to Black Organic Silt, Some Sand, Little Gravel	117.9	55	42	13	18.7	2.59	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	60.6	NA	NA	NA
	SOUTH 4-8 ft	DSS 39, 34	021412001	Dark Brown to Black Organic Silt, Some Sand, Little Gravel	99.0	53	45	8	20.4	2.40	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	65.2	NA	NA	NA
	SOUTH 8 ft-Native	DSS 39, 34	021412004	Dark Brown to Black Organic Silt, Some Sand and Gravel	62.1	NP	NP	NP	19.2	2.43	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	51.3	NA	NA	NA
	DSS TILL	DSS 2, 15, 22, 12, 28	021412005	Gray Organic Clay, Some Sand, Trace Gravel	17.8	30	18	12	6.4	2.61	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	72.6	NA	NA	NA
	16.5-18.5	STA-62DSS	100313253	Gray Silty Clay, Some Fine to Medium Sand, Trace Gravel	15.5	22	17	5	1.7	NA	1.2177	0.4109	0.0219	0.0145	0.005	NA	NA	NA	NA	79.4	75.1	NA	CL-ML	10/21/2013
	18.5-24.5	Geo 1/STA-47DSS																						
	32.5-37.5	Geo 1/STA-47DSS																						
	29.5-30	Geo 2/STA-70 DSS																						
	34-35.5	Geo 2/STA-70 DSS																						
	9.5-10.5	Geo 1/STA-47DSS	100313255	Dark Gray Lean Clay, Some Fine to Medium Sand, Little Gravel	18.3	28	17	11	1.7	NA	3.2025	1.1771	0.0228	0.0109	0.0022	NA	NA	NA	NA	73.3	70.3	NA	CL	10/21/2013
	10.5-12.5	Geo 3/STA-68DSS																						
	12.5-14.5	STA-19 DSS																						
	14.5-15.5	STA-21 DSS-RVT																						
	15.5-16.5	STA-61 DSS																						
	16.5-20.5	STA-26 DSS																						
	10.5-12.5	STA-67 DSS																						
	9.5-10.5	STA-63 DSS																						
	38.5-39.5	STA-47 DSS	100313256	Brown Gravel, Some Fine to Medium Sand and Silt, Little Clay	7.6	NV	NP	NP	0.6	NA	33.0495	30.5411	12.1549	2.666	0.1036	0.016	0.0089	1371.85	0.1	31.8	28.1	NA	GM	10/21/2013

Table 4 - Step I and Step II Sediment Geotechnical Data

Remedial Investigation Report Rev. 1
The Peoples Gas Light and Coke Company
Willow Street, Division Street and North Station Operable Units 2 (River)
The North Branch Site, Cook County, Chicago, IL
USEPA ID: ILD982074759 (Willow), ILD982074783 (Division) and ILD982074775 (North Station)

Operable Unit ARA	Depth Range	Station Cores in Composite	Sample ID	Sample Description	Natural Moisture (%)	Atterberg Limits			Organic Content (%)	Specific Gravity	Coefficients									P100 Content (%)	P200 Content (%)	Unconfined Compressive Strength (psf)	USCS	Data Date
						Liquid Limit (%)	Plastic Limit (%)	PI			D90	D85	D60	D50	D30	D15	D10	CU	CC					
Division Street ARA	16.5-18.5	STA-61 DSS	100313257	Brown Silty Fine to Medium Sand, Trace Gravel	16.5	NV	NP	NP	1.9	NA	1.1836	0.6861	0.2241	0.1698	0.0216	0.004	0.0017	132.53	1.24	47.7	42.2	NA	SM	10/21/2013
	0.5-6.5	STA-19DSS	100313258	Dark Gray Organic Silt to Sedimentary Peat, Some Sand, Trace Gravel	130.4	NV	NP	NP	13.8	NA	0.2224	0.1241	0.0322	0.0213	0.008	0.0021	NA	NA	NA	86.4	81.4	NA	OL/PT	10/21/2013
	5.5-7.5	STA-21DSS-RVT																						
	7.5-8.5	STA-61 DSS																						
	8.5-10.5	Geo 1/STA47DSS																						
	10.5-11.5	STA-25A DSS																						
	16.5-17.5	Geo 3/STA-68 DSS																						
	0.5-2.5	STA-67 DSS																						
	2.5-3.5	STA-63 DSS																						
	2.5-4.5	Geo2/STA-70DSS Shelby Tube	100313259	Gray Organic Silt to Sedimentary Peat, Some Fine to Medium Sand, Trace Gravel	116.4	NV	NP	NP	13.6	2.00	0.3344	0.1905	0.0461	0.0316	0.0112	0.0041	0.0022	20.64	1.21	82.3	75.1	62	OL/PT	10/21/2013
	2.5-4.5	Geo4/STA-71DSS Shelby Tube	100313260	Gray Organic Silt, Some Sand, Trace Gravel	126.3	NA	NP	NA	10.6	2.04	0.223	0.1568	0.0575	0.0356	0.0118	0.0034	0.0022	26.24	1.1	84.6	77.5	63	OL	10/21/2013
	10-12	Geo6/PCA-45DSS Shelby Tube	100313261	Dark Gray Sandy Organic Silt to Sedimentary Peat, Trace Gravel	88.3	NV	NP	NP	16.4	2.22	0.5122	0.311	0.0608	0.0337	0.0101	0.0035	NA	NA	NA	73	63.9	137	OL/PT	10/21/2013
	4.5-6.5	Geo9/STA-83DSS Shelby Tube	120513834	Very Dark Gray to Black Organic Sandy Silt, Trace Gravel	81.0	NV	NP	NV	6.4	2.35	2.0627	1.1948	0.1086	0.0683	0.0156	NA	NA	NA	NA	65.3	NA	59	ML	12/24/2013
	12.5-14.5	Geo9/STA-83DSS Shelby Tube	120513841	Dark Gray Lean Clay, Some Sand, Trace Gravel	16.4	26	17	9	1.3	2.71	1.0675	0.4553	0.0351	0.0175	0.0043	NA	NA	NA	NA	76.7	72.4	4695	CL	12/24/2013
North Station ARA	8.5-9.5	PCA-3 NOS	120613661	Dark Brown Organic Silt, Some Sand, Trace Gravel	53.7	48	32	16	8.2	NA	0.5557	0.2589	0.0587	0.0211	0.0056	NA	NA	NA	NA	79.6	NA	NA	ML	12/24/2013
	13.5-15.5	PCA-30 NOS																						
	15.5-16.5	PCA-26 NOS																						
	16.5-17.5	PCA-11 NOS																						
	15.5-18.5	PCA-8 NOS																						
	2.5-7.5	PCA-3 NOS	120613660	Black Organic Sandy Silt, Trace Gravel	160.3	NV	NP	NP	11.0	NA	0.1355	0.1174	0.072	0.0579	0.0135	NA	NA	NA	NA	92.2	NA	NA	ML	12/24/2013
	3.5-6.5	PCA-26 NOS																						
	4.5-6.5	PCA-11 NOS																						
	2.5-5.5	PCA-32 NOS																						
	18.5-19.5	PCA-3 NOS	120613659	Dark Gray Lean Clay, Some Sand, Trace Gravel	20.3	29	18	11	1.2	NA	1.0031	0.3482	0.018	0.0079	0.0018	NA	NA	NA	NA	79.7	76.3	NA	CL	12/24/2013
	21.5-24.5	PCA-30 NOS																						
	20.5-22.5	PCA-26 NOS																						
	11.5-12.5	PCA-11 NOS																						
	15.5-16.5	PCA-8 NOS																						
	16.5-18.5	PCA-2 NOS																						
	15.5-18.5	PCA-32 NOS																						
	16.5-21.5	PCA-30 NOS	120613658	Very Dark Gray Fine to Coarse Sand, Little Silt, Clay and Gravel, Trace Organics	35.0	NV	NP	NP	3.7	NA	5.1031	3.9312	1.4981	1.0473	0.3389	0.1364	0.0279	53.73	2.75	16	12.6	NA	SM	12/24/2013

Table 5A - Samples Collected for MGP Residual Mobility Testing

Remedial Investigation Report Rev. 1
The Peoples Gas Light and Coke Company
Willow Street, Division Street and North Station Operable Units 2 (River)
The North Branch Site, Cook County, Chicago, IL
USEPA ID: ILD982074759 (Willow), ILD982074783 (Division) and ILD982074775 (North Station)

Operable Unit ARA	Station Name	Sample Depth (feet below mudline)	Sample Description
Willow Street	PCA-13WHS	8.5-10.5	NAPL wettted sediment
Willow Street	PCA-15WHS	8.5-10.5	Oil wetted, weathered tar like pieces
Willow Street	PCA-32WHS	4.5-6.5	Oil wetted, mothball-like odor
Willow Street	PCA-40WHS	7.5-9.5	Weathered tar-like pieces (2-3mm)
Willow Street	PCA-43WHS	9.0-11.0	Oil wetted, mothball like odor, oil in droplets
Division Street	STA-8DSS	11.0-13.0	Strong MGP-like odor, oil-coated sediment
Division Street	STA19-DSS	12.5-14.5	Oil-wetted in droplets (~15%), strong odor, sheen
Division Street	STA-22DSS	19.0-21.0	Oil-wetted, mothball-like odor, weathered tar-like pieces
Division Street	STA-45DSS	4.5-6.5	Mothball-like odor, oil-wetted in the form of 3-to-5 mm black oil droplets
Division Street	STA-71DSS/Geotech4	5.0-7.0	Oil-wetted in droplets, mothball-like odor
North Station	PCA-12NOS	12.5-14.5	Oil-wetted, weathered tar-like pieces ~2-3 mm
North Station	PCA-32NOS	8.5-10.5	Mothball-like odor, oil wetted with weathered tar-like pieces
North Station	PCA-32NOS	12.5-14.5	Petroleum-like odor, oil-coated sand grains

Table 5B - Summary of Elevation of NAPL Observations

Remedial Investigation Report Rev. 1
The Peoples Gas Light and Coke Company
Willow Street, Division Street and North Station Operable Units 2 (River)
The North Branch Site, Cook County, Chicago, IL
USEPA ID: ILD982074759 (Willow), ILD982074783 (Division) and ILD982074775 (North Station)

Operable Unit 2	Station Name	Sediment Surface Elevation from Boring Log (NAVD88)	USACE Federally Authorized Channel Depth (NAVD88)	Sediment Sample Surface Elevation Relative to Federally Authorized Channel Depth (NAVD88)	DNAPL Top Observations (depth below top of sediment; ft)	DNAPL bottom Observations (depth below top of sediment; ft)	DNAPL Observations Top Elevation (NAVD88)	DNAPL Observations Bottom Elevation (NAVD88)	DNAPL Top Observation Below Federally Authorized Channel Depth (ft)	DNAPL Bottom Observation Below Federally Authorized Channel Depth (ft)
Willow Street	PCA-13WHS	567.7	569.71	-2.01	-8.5	-14.5	559.20	553.20	-10.51	-16.51
Willow Street	PCA-15WHS-RVT	566.0	569.71	-3.71	-8.5	-10.5	557.50	555.50	-12.21	-14.21
Willow Street	PCA-32WHS	567.8	569.71	-1.91	-2.5	-6.3	565.30	561.50	-4.41	-8.21
Willow Street	PCA-37WHS	566.8	569.71	-2.91	-8.9	-10.5	557.90	556.30	-11.81	-13.41
Willow Street	PCA-40WHS	561.7	569.71	-8.01	-5.5	-10.9	556.20	550.80	-13.51	-18.91
Willow Street	PCA-43WHS	563.3	569.71	-6.41	-10.9	-11.4	552.40	551.90	-17.31	-17.81
Division Street	STA-11DSS	560.3	557.51	2.79	-9.5	-12.0	550.80	548.30	-6.71	-9.21
Division Street	STA-19DSS-RVT	567.9	557.51	10.39	-12.7	-13.7	555.20	554.20	-2.31	-3.31
Division Street	STA-1DSS-RVT	577.1	557.51	19.59	-18.5	-19.5	558.60	557.60	**1.09**	**0.09**
Division Street	STA-22DSS_RVT	569.5	557.51	11.99	-19.6	-21.6	549.90	547.90	-7.61	-9.61
Division Street[1]	STA-24DSS	560.4	557.51	2.89	-2.9	-6.9	557.50	553.50	**-0.01**	-4.01
Division Street	STA-26ADSS	565.6	557.51	8.09	-14.1	-14.3	551.50	551.30	-6.01	-6.21
Division Street	STA-2DSS	566.3	557.51	8.79	-14.5	-15.5	551.80	550.80	-5.71	-6.71
Division Street	STA-30DSS	562.6	557.51	5.09	-8.0	-8.5	554.60	554.10	-2.91	-3.41
Division Street	STA-45DSS	558.4	557.51	0.89	-6.3	-6.5	552.10	551.90	-5.41	-5.61
Division Street	STA-46DSS	564.1	557.51	6.59	-11.8	-12.3	552.30	551.80	-5.21	-5.71
Division Street	STA-48DSS	559.8	557.51	2.29	-8.3	-8.9	551.50	550.90	-6.01	-6.61
Division Street	STA-4DSS-RVT	564.1	557.51	6.59	-10.4	-12.9	553.70	551.20	-3.81	-6.31
Division Street	STA-50DSS	559.1	557.51	1.59	-6.5	-8.5	552.60	550.60	-4.91	-6.91
Division Street	STA-51DSS	559.1	557.51	1.59	-7.7	-8.2	551.40	550.90	-6.11	-6.61
Division Street	STA-52DSS	559.1	557.51	1.59	-7.5	-8.5	551.60	550.60	-5.91	-6.91
Division Street	STA-54DSS	565.2	557.51	7.69	-6.8	-8.5	558.40	556.70	**0.89**	-0.81
Division Street	STA-58DSS	560.9	557.51	3.39	-8.5	-10.8	552.40	550.10	-5.11	-7.41
Division Street	STA-5DSS	564.5	557.51	6.99	-13.4	-13.5	551.10	551.00	-6.41	-6.51
Division Street	STA-63DSS	557.8	557.51	0.29	-3.5	-4.7	554.30	553.10	-3.21	-4.41
Division Street	STA-64DSS	567.1	557.51	9.59	-8.5	-8.7	558.60	558.40	**1.09**	**0.89**
Division Street	STA-65DSS	558.1	557.51	0.59	-4.5	-6.5	553.60	551.60	-3.91	-5.91
Division Street	STA-67DSS	562.6	557.51	5.09	-10.1	-10.3	552.50	552.30	-5.01	-5.21
Division Street	STA-6DSS	565.0	557.51	7.49	-14.5	-16.5	550.50	548.50	-7.01	-9.01
Division Street	STA-71DSS	561.9	557.51	4.39	-5.5	-6.8	556.40	555.10	-1.11	-2.41
Division Street	STA-76DSS	565.8	557.51	8.29	-16.5	-17.9	549.30	547.90	-8.21	-9.61
Division Street	STA-7DSS	561.5	557.51	3.99	-10.0	-12.0	551.50	549.50	-6.01	-8.01
Division Street	STA-80DSS	566.8	557.51	9.29	-10.5	-11.0	556.30	555.80	-1.21	-1.71
Division Street	STA-8DSS	563.5	557.51	5.99	-11.9	-14.5	551.60	549.00	-5.91	-8.51
Division Street	STA-9DSS	563.7	557.51	6.19	-11.5	-12.0	552.20	551.70	-5.31	-5.81
North Station[2]	PCA-12NOS	565.3	NA	NA	-12.5	-14.5	552.80	550.80	NA	NA
North Station[2]	PCA-32NOS	566.3	NA	NA	-8.5	-14.7	557.80	551.60	NA	NA
North Station[2]	PCA-33NOS	566.4	NA	NA	-4.5	-11.3	561.90	555.10	NA	NA

Notes:
1. Location STA-24DSS was calculated to be above the USACE federally authorized channel depth when compared to bathymetery data so is included on the list for locatoins above the authorized channel depth.
2. North Station is located on the North Branch Canal, which is not part of the USACE federally authorized channel depth.
Cells shaded in gray and bolded indicate elevations above the USACE federally authorized channel depth (including STA-24DSS). See Figure 14B for locations.
DNAPL = dense non-aqueous phase liquid
NAVD88 = North American Vertical Datum of 1988
USACE = United States Army Corp of Engineers

Table 9 - Forensic PAH Samples Greater than UTL Screening Levels

Remedial Investigation Report Rev. 1
The Peoples Gas Light and Coke Company
Willow Street, Division Street and North Station Operable Units 2 (River)
The North Branch Site, Cook County, Chicago, IL
USEPA ID: ILD982074759 (Willow), ILD982074783 (Division) and ILD982074775 (North Station)

Operable Unit 2	Sample 9 Digit Code	Field Sample ID	Sample Date	Sample Top	Sample Bottom	OBG TPAH (mg/kg)	Surface vs. Subsurface UTL Exceedance	Ambient or MGP derived impact (Exponent)
Willow	020312627	PCA-20WHS (14.5-15.5)	2/3/2012 12:45	14.5	15.5	434.34	Subsurface	Potential MGP
	020312628	PCA-20WHS (15.5-16.5)	2/3/2012 12:45	15.5	16.5	516.56	Subsurface	Potential MGP
	020612691	PCA-15WHS (15.5-16.5)	2/6/2012 14:25	15.5	16.5	12912.00	Subsurface	Potential MGP
	020712703	PCA-13WHS (13.5-14.5)	2/7/2012 9:10	13.5	14.5	3959.30	Subsurface	Potential MGP
	020812773	PCA-9WHS (10.5-11.5)	2/8/2012 11:18	10.5	11.5	2662.60	Subsurface	Potential MGP
	020812774	PCA-9WHS (11.5-12.5)	2/8/2012 11:18	11.5	12.5	778.63	Subsurface	Potential MGP
	020812775	PCA-9WHS (12.5-13.5)	2/8/2012 11:25	12.5	13.5	5122.80	Subsurface	Potential MGP
	020812776	PCA-9WHS (13.5-14.5)	2/8/2012 11:25	13.5	14.5	910.41	Subsurface	Potential MGP
	020812790	PCA-7WHS (10.5-11.5)	2/8/2012 13:15	10.5	11.5	917.00	Subsurface	Potential MGP
	020812808	PCA-6WHS (13.5-14.5)	2/8/2012 14:55	13.5	14.5	702.34	Subsurface	Potential MGP
	021012915	PCA-25WHS (11.5-12.5)	2/10/2012 12:30	11.5	12.5	1053.14	Subsurface	Potential MGP
	100213170	PCA-32WHS (3.5-4.5)	10/2/2013 8:44	3.5	4.5	1019.90	Subsurface	Potential MGP
	100213171	PCA-32WHS (4.5-5.5)	10/2/2013 8:44	4.5	5.5	645.92	Subsurface	Potential MGP
	100213173	PCA-32WHS (6.5-7.5)	10/2/2013 9:07	6.5	7.5	2274.25	Subsurface	Potential MGP
	100213174	PCA-32WHS (7.5-8.5)	10/2/2013 9:07	7.5	8.5	1392.10	Subsurface	Potential MGP
	100213191	PCA-37WHS (9.5-10.5)	10/2/2013 11:42	9.5	10.5	757.56	Subsurface	Potential MGP
	100213209	PCA-24WHS-RVT (13.5-14.5)	10/2/2013 14:47	13.5	14.5	1425.75	Subsurface	Potential MGP
	110413441	PCA-29WHS (9.5-10.5)	11/4/2013 13:15	9.5	10.5	516.65	Subsurface	Potential MGP
	110713492	PCA-44WHS (6.5-8.5)	11/7/2013 0:00	6.5	8.5	491.31	Subsurface	Potential MGP
	121013519	PCA-32WHS MOB (4.5-6.5)	12/10/2013 13:55	4.5	6.5	686.52	Subsurface	Potential MGP
Division	020212544	STA-3DSS (0.5-1.5)	2/2/2012 14:08	0.5	1.5	878.00	Surface	Ambient
	082713025/082713050 (N)	STA-21DSS-RVT (0-0.5)	8/27/2013 8:35	0	0.5	385.80	Surface	Ambient
	091713589	STA-72DSS (19.5-20.5)	9/17/2013 9:15	19.5	20.5	438.91	Subsurface	Ambient
	121013869	STA-45DSS MOB (4.5-6.5)	12/10/2013 11:30	4.5	6.5	695.20	Subsurface	Ambient
	012512116	STA-37DSS (12.5-13.5)	1/25/2012 11:02	12.5	13.5	4468.40	Subsurface	Potential MGP
	012512136	STA-36DSS (15.5-16.5)	1/25/2012 13:20	15.5	16.5	761.84	Subsurface	Potential MGP
	012612174	STA-35DSS (10.5-11.5)	1/26/2012 10:41	10.5	11.5	1237.90	Subsurface	Potential MGP
	012712236	STA-12DSS (7.5-8.5)	1/27/2012 9:57	7.5	8.5	2879.50	Subsurface	Potential MGP
	012712252	STA-32DSS (11.5-12.5)	1/27/2012 11:35	11.5	12.5	2341.70	Subsurface	Potential MGP
	012712253	STA-32DSS (12.5-13.5)	1/27/2012 11:45	12.5	13.5	863.88	Subsurface	Potential MGP
	013012330	STA-8DSS (11.5-12.5)	1/30/2012 14:25	11.5	12.5	855.66	Subsurface	Potential MGP
	013112410	STA-6DSS (12.5-13.5)	1/31/2012 14:37	12.5	13.5	414.68	Subsurface	Potential MGP
	020112442	STA-24DSS (5.5-6.5)	2/1/2012 10:40	5.5	6.5	10507.70	Subsurface	Potential MGP
	020112445	STA-24DSS (2.5-3.5)	2/1/2012 10:35	2.5	3.5	23409.00	Subsurface	Potential MGP
	082613015	STA-19DSS-RVT (12.5-13.5)	8/26/2013 14:11	12.5	13.5	2203.50	Subsurface	Potential MGP
	090313200	STA-25ADSS (17.5-18.5)	9/3/2013 10:30	17.5	18.5	2147.20	Subsurface	Potential MGP
	090313201	STA-25ADSS (18.5-19.5)	9/3/2013 15:15	18.5	19.5	3494.20	Subsurface	Potential MGP
	090313204	STA-25ADSS (21.5-22.5)	9/3/2013 15:25	21.5	22.5	1826.10	Subsurface	Potential MGP
	091213518	STA-64DSS (8.5-9.5)	9/12/2013 14:20	8.5	9.5	1153.40	Subsurface	Potential MGP
	090313204/090313209 (N)	STA-25ADSS (21.5-22.5) (N)	9/3/2013 15:25	21.5	22.5	1826.10	Subsurface	Potential MGP
North Station	111113025	PCA-1NOS (0.5-1.5)	11/11/2013 8:35	0.5	1.5	527.51	Surface	Ambient
	120413646	PCA-6ANOS (0.5-1.5)	12/4/2013 12:15	0.5	1.5	538.40	Surface	Ambient
	112013343	PCA-19NOS (11.5-12.5)	11/20/2013 12:12	11.5	12.5	1382.60	Subsurface	Potential MGP
	120313601	PCA-20NOS (12.5-13.5)	12/3/2013 12:17	12.5	13.5	468.37	Subsurface	Potential MGP
	120313602	PCA-20NOS (13.5-14.5)	12/3/2013 12:50	13.5	14.5	553.13	Subsurface	Potential MGP
	120913662	PCA-32NOS MOB (8.5-10.5)	12/9/2013 9:47	8.5	10.5	2333.90	Subsurface	Potential MGP

Surface UTL Exceedance >342 mg/kg
Subsurface UTL > 410 mg/kg

Notes:
OBG Total PAH calculated values
TPAH - total polycyclic aromatic hydrocarbons
UTL - upper tolerance limit
mg/kg - milligrams per kilogram

Table 10 - Benthic Survey Presence/Absence Report

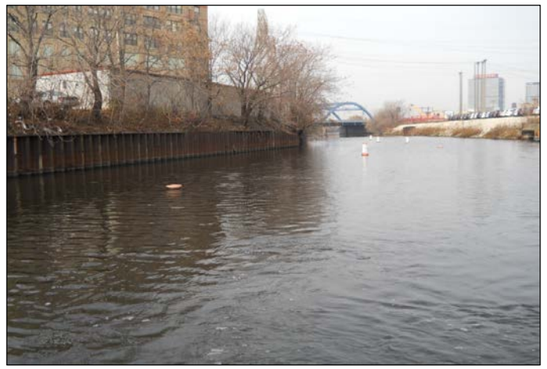
Remedial Investigation Report Rev. 1
The Peoples Gas Light and Coke Company
Willow Street, Division Street and North Station Operable Units 2 (River)
The North Branch Site, Cook County, Chicago, IL
USEPA ID: ILD982074759 (Willow), ILD982074783 (Division) and ILD982074775 (North Station)

Sample Information							Coordinates		Sediment Information			Presence (X) / Absence ( )		
Nearest Surface water Sample	Nearest Station ID	Approximate Location to Site	Sample Location	Sample Depth, Top of Sediment (feet)	Sample Date	Sample Time	X	Y	Sediment Classification	Sediment Description	Field Observations of Sediment Boring	Oligochaetes	Chironomidae	Observations
SWS-1WHS	PCA-8WHS	Mid-Site (Willow Street)	WHS-1	0-0.5	11/13/2012	7:45	445448.826	4640276.016	ML	Silt, Woody Debris, Organic Material	No significant field observations of potential MGP-related effects	X	X	abundant worms, leeches present, freshwater Isopod present
SWS-2WHS	PCA-19WHS	Mid-Site (Willow Street)	WHS-2	0-0.5	11/13/2012	9:20	445484.101	4640165.013	ML	Silt, Woody Debris, Organic Material, Shell Fragments	No significant field observations of potential MGP-related effects	X		Asiatic clam (*Corbicula* sp.) present
SWS-1DIV	STA-21DSS	Upstream Portion of Site (Division Street)	DIV-1	0-0.5	11/12/2013	10:35	445452.095	4639336.438	ML	Silt, Woody Debris, Organic Material, Shell Fragments	No significant field observations of potential MGP-related effects	X		Asiatic clam (*Corbicula* sp.) present
SWS-2DIV	STA-30DSS	Mid-Site (Division Street)	DIV-2	0-0.5	11/12/2013	11:30	445585.104	4639085.999	ML	Silt, Organic Material	Oil-coated sediment between 8 and 8.5 feet			
SWS-13NOS	PCA-33NOS	Mid-Site (North Station)	PCA-33NOS	0-0.5	3/8/2013	--	446316.284	4639033.519	ML	Silt, Organic Material	Oil-wetted, tar-like material and weather tar-like pieces were observed in the core at depths between 4.5 and 11.3 ft below mudline			
SWSW-10NOS	PCA-31NOS	Downstream Portion of Site (North Station)	PCA-31NOS	0-0.5	3/8/2013	--	446382.581	4638943.137	ML	Silt, Organic Material	Petroleum-like odors were observed in the core at depths of 7.5-8.5 ft below mudline	X		Tubeificidae

Notes:
Samples collected with Ponar grab sampler at each location.
Samples sieved to remove fine sediments.

Operable Unit 2 Habitat at Willow Street

Operable Unit 2 Habitat at Division Street



Operable Unit 2 Habitat at North Station

Table 11 - Vertical Total PAH Exceedance Delineation Table

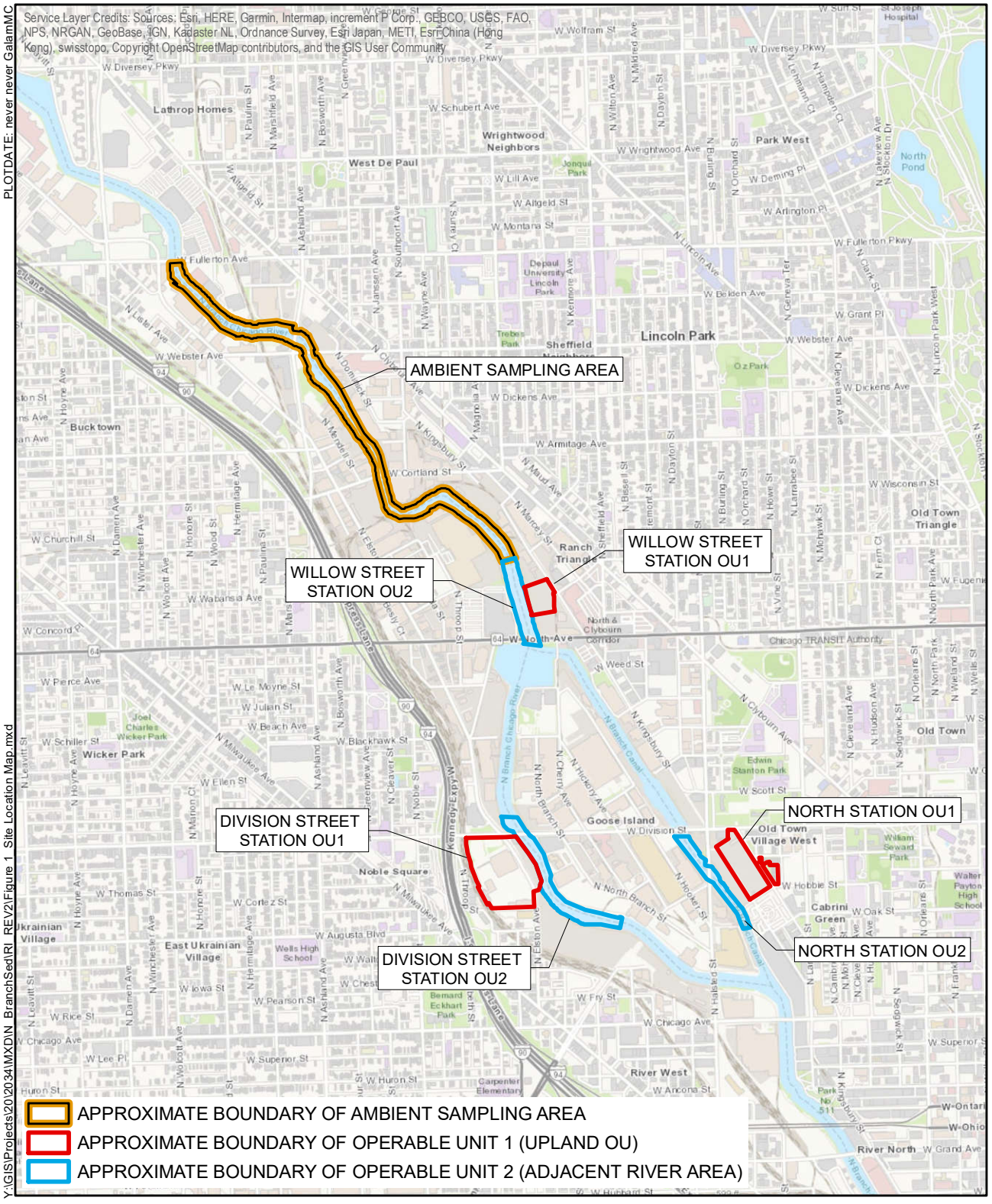
Remedial Investigation Report Rev. 1
The Peoples Gas Light and Coke Company
Willow Street, Division Street and North Station Operable Units 2 (River)
The North Branch Site, Cook County, Chicago, IL
USEPA ID: ILD982074759 (Willow), ILD982074783 (Division) and ILD982074775 (North Station)

Operable Unit	Location	Exceedances	Soil Sample IDs and Depth	Depth of Exceedances or Observations of affected soils (feet bgs)	Vertical Extent Defined?	Vertical Extent Data	Lateral Extent Defined?		Lateral Extent Data
Willow	PCA-20WHS	TPAH exceedance reported in deepest sample	PCA-20WHS (15.5 - 16.5)	14.5-15.5 feet, 15.5-16.5 feet bgs	Yes	Deeper soil sample collected in boring PCA-20WHS-RVT from 16.5 - 17.5 feet and 18.5-19.5 feet bgs that were below screening value.	North	Yes	Clay tagged and no exceedances of UTL reported in location PCA-38WHS
							East	Yes	River Wall
							South	Yes	Clay tagged and no exceedances of UTL reported in location PCA-40WHS
							West	Yes	Clay tagged and no exceedances of UTL reported in location PCA-39WHS
	PCA-15WHS	TPAH exceedance reported in deepest sample	PCA-15WHS (15.5 - 16.5)	15.5-16.5 feet bgs	Yes	Deeper soil sample collected in boring PCA-15WHS-RVT from 16.5 - 17.5 feet bgs that were below screening value.	North	Yes	Clay tagged and no exceedances of UTL reported in location PCA-32WHS
							East	Yes	Clay tagged and no exceedances of UTL reported in location PCA-36WHS
							South	Yes	Clay tagged and no exceedances of UTL reported in location PCA-35WHS
							West	No	Western sample is GEOTECH sample, no analytical data
	PCA-32WHS MOB	TPAH exceedance reported in deepest sample	PCA-32WHS MOB (4.5-5.5)	4.5-5.5 feet bgs	Yes	Deeper samples collected from adjacent boring PCA-32WHS	North	Yes	Clay tagged and no exceedances of UTL reported in location STA-13WHS (8.5-10.5')
							East	Yes	River Wall
							South	Yes	Clay tagged and no exceedances of UTL reported in location STA-15WHS (15.5-16.5) and STA-15WHS-RVT (16.5-17.5')
							West	Yes	Clay tagged and no exceedances of UTL reported in location STA-31WHS (14.5-15.5')
Division	STA-12DSS	TPAH exceedance reported in deepest sample (clay)	STA-12DSS (7.5 - 8.5)	7.5 - 8.5 feet bgs	No	No deeper samples collected at surrounding lateral samples	North	No	Clay tagged and no UTL exceedance reported below 10.5-11.5 feet in STA-58DSS.
							East	Yes	TPAH UTL exceedance reported in boring STA-32DSS above the clay.
							South	Yes	Clay tagged at 4.5 feet at STA-63DSS, no UTL exceedance reported from sample collected above the clay (4.5-5.5').
							West	Yes	River Wall
	STA-32DSS	TPAH exceedance reported in deepest sample (clay)	STA-32DSS (12.5 -13.5)	12.5 - 13.5 feet bgs	No	Clay was tagged at a shallower elevation at surounding locations.	North	No	Clay tagged and no UTL exceedance at last interval above clay interface at STA-31DSS (9.5-10.5')
							East	Yes	River Wall
							South	Yes	Clay tagged and no exceedances of UTL reported in location STA-64DSS (10.5-11.5')
							West	No	Clay tagged, exceedances of UTL reported in location STA-12DSS (7.5-8.5'), just above the clay
	STA-35DSS	TPAH exceedance reported in deepest sample (clay)	STA-35DSS (12.5 -13.5)	10.5-11.5 feet bgs	No	Clay was tagged at a shallower elevation at surounding locations.	North	Yes	River Wall
							East	No	Final sample collected at STA-36DSS (15.5-16.5) exceeded UTL.
							South	Yes	Clay tagged and no exceedances of UTL reported in location STA-79DSS (9.5-10.5')
							West	Yes	Clay tagged and no exceedances of UTL reported in location STA-65DSS (7.5-8.5)
	STA-36DSS	TPAH exceedance reported in deepest sample (clay)	STA-36DSS (15.5 -16.5)	15.5-16.5 feet bgs	No	Clay was tagged at a shallower elevation at surounding locations.	North	Yes	River Wall
							East	No	Location STA-36DSS reported UTL exceedance in sample collected above the clay (12.5-13.5).
							South	Yes	Clay tagged and no exceedances of UTL reported in adjacent location STA-16DSS (11.5-12.5')
							West	No	Clay tagged and UTL exceedance in deepest sample reported in location STA35-DSS (10.5-11.5)
	STA-37DSS	TPAH exceedance reported in deepest sample	STA-37DSS (12.5-13.5)	12.5-13.5 feet bgs	No	Clay was tagged at a shallower elevation at surounding locations.	North	Yes	River Wall
							East	Yes	Clay tagged in STA-67DSS, no exceedances of UTL in sample (11.5-12.5) collected in clay (below oil-wetted/oil/coated observation).
							South	Yes	Clay tagged and no exceedances of UTL reported in location STA-38DSS-RVT (10.5-11.5)
							West	Yes	Clay tagged and no exceedances of UTL reported in location STA-16DSS (11.5-12.5)
	STA-45DSS	TPAH exceedance reported in deepest sample	STA-45DSS (4.5-6.5)	4.5-6.5 feet bgs	Yes	Deeper soil sample collected in boring STA-24DSS from 7.5 - 8.5 feet bgs that were below screening value.	Adjacent	Yes	Deeper soil sample collected in boring STA-24DSS from 7.5 - 8.5 feet bgs that were below screening value.

Notes:
bgs - below ground surface
TPAH - total polycyclic aromatic hydrocarbons
UTL - upper tolerance limit

Figures

FIGURE 1



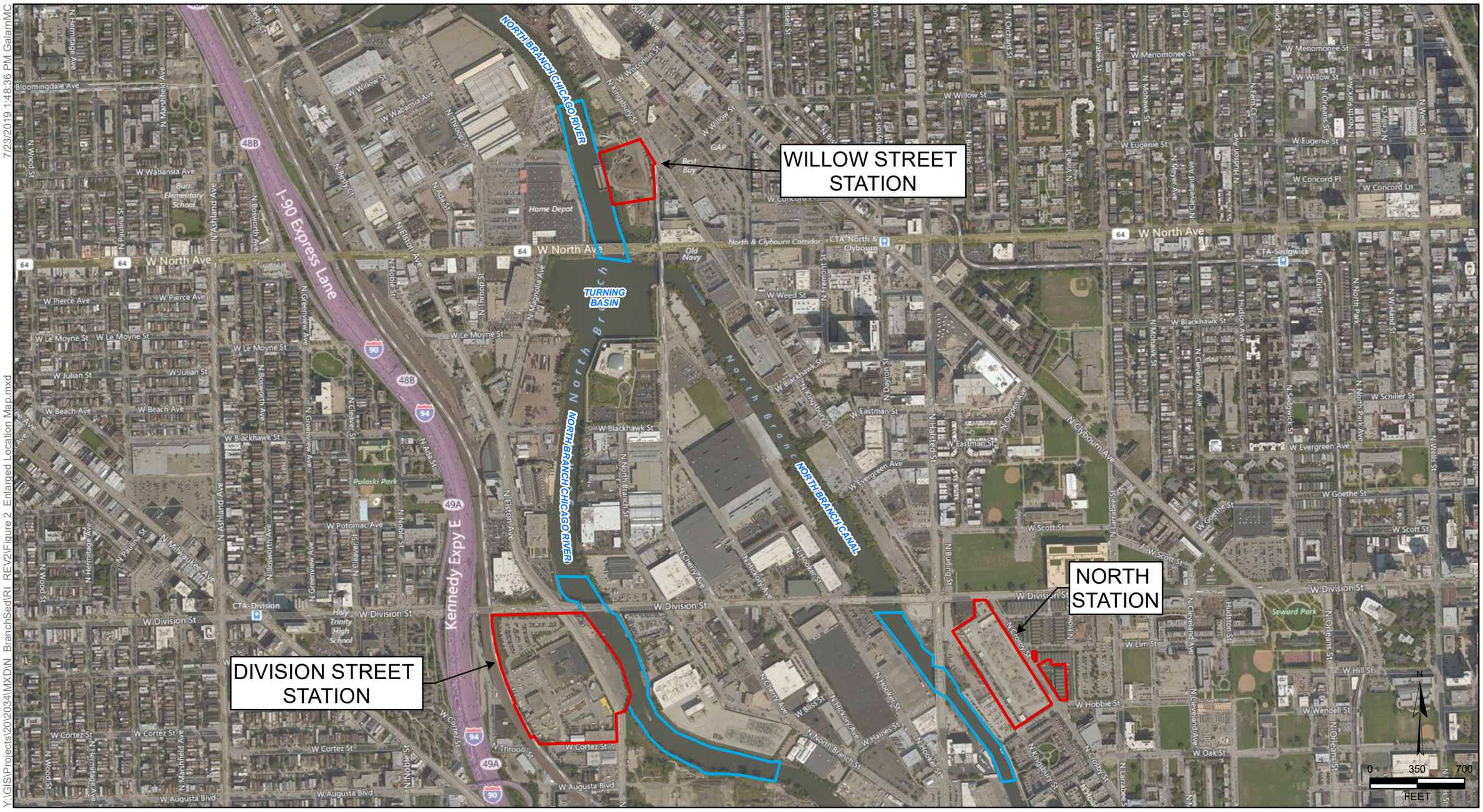
REMEDIAL INVESTIGATION REPORT
NORTH BRANCH SEDIMENT INVESTIGATION
CHICAGO, ILLINOIS

N

SITE LOCATION MAP

0 1,000 2,000 4,000
Feet

O'BRIEN & GERE ENGINEERS, INC.



APPROXIMATE BOUNDARY OF OPERABLE UNIT 1 (UPLAND OU)

APPROXIMATE BOUNDARY OF OPERABLE UNIT 2 (ADJACENT RIVER AREA)

SOURCE: PROPERTY LINE INFORMATION OBTAINED FROM COOK COUNTY, ILLINOIS 1:1200-SCALE PARCEL DIGITAL DATA SET, VERSION 1.0, JUNE 2012. OPERABLE UNIT BOUNDARY PROVIDED BY BURNS & MCDONNEL, PROJECT NUMBER 51893, DATED SEPTEMBER 21,2009

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REMEDIAL INVESTIGATION REPORT
NORTH BRANCH SEDIMENT INVESTIGATION
CHICAGO, ILLINOIS

ENLARGED LOCATION MAP
NORTH BRANCH SITES

O'BRIEN & GERE ENGINEERS, INC.

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Y:\GIS\Projects\202034\MXD\N_BranchSed\RI_REV2\Figure 2_Enlarged Location Map.mxd

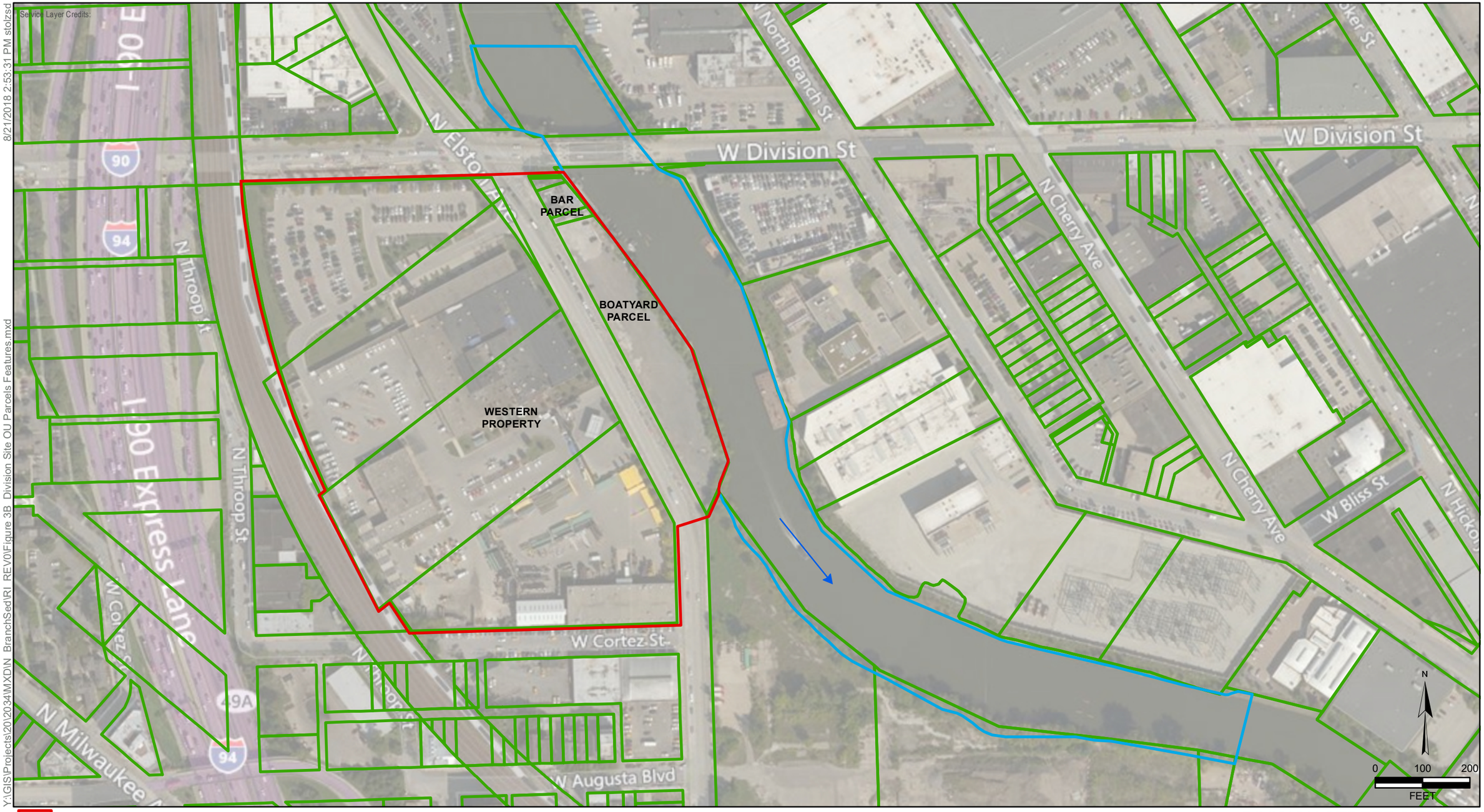
APPROXIMATE BOUNDARY OF OPERABLE UNIT 1 (UPLAND OU)
APPROXIMATE BOUNDARY OF OPERABLE UNIT 2 (ADJACENT RIVER AREA)
CITY OF CHICAGO PARCEL

SOURCE: PROPERTY LINE INFORMATION OBTAINED FROM COOK COUNTY, ILLINOIS 1:1200-SCALE PARCEL DIGITAL DATA SET, VERSION 1.0, JUNE 2012. OPERABLE UNIT BOUNDARY PROVIDED BY BURNS & MCDONNEL, PROJECT NUMBER 51893, DATED SEPTEMBER 21,2009

REMEDIAL INVESTIGATION REPORT
NORTH BRANCH SEDIMENT INVESTIGATION
CHICAGO, ILLINOIS

WILLOW STREET SITE [OU]
PARCEL BOUNDARIES AND SITE FEATURES

O'BRIEN & GERE ENGINEERS, INC.



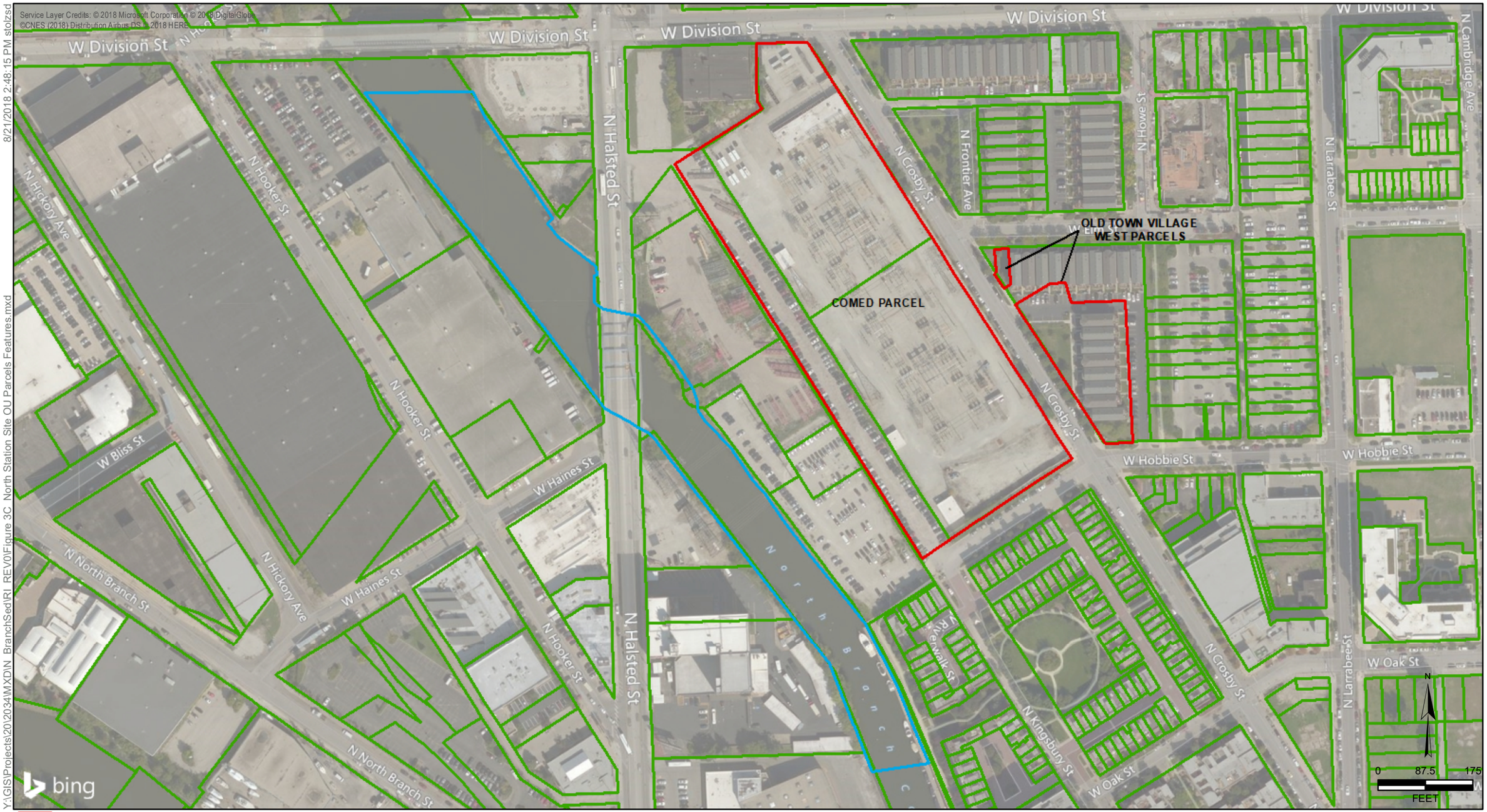
APPROXIMATE BOUNDARY OF OPERABLE UNIT 1 (UPLAND OU)
APPROXIMATE BOUNDARY OF OPERABLE UNIT 2 (ADJACENT RIVER AREA)
CITY OF CHICAGO PARCEL

REMEDIAL INVESTIGATION REPORT
NORTH BRANCH SEDIMENT INVESTIGATION
CHICAGO, ILLINOIS

DIVISION STREET SITE [OU]
PARCEL BOUNDARIES AND SITE FEATURES

SOURCE: PROPERTY LINE INFORMATION OBTAINED FROM COOK COUNTY, ILLINOIS 1:1200-SCALE PARCEL DIGITAL DATA SET, VERSION 1.0, JUNE 2012. OPERABLE UNIT BOUNDARY PROVIDED BY BURNS & MCDONNEL, PROJECT NUMBER 51893, DATED SEPTEMBER 21,2009

O'BRIEN & GERE ENGINEERS, INC.



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Y:\GIS\Projects\20\20341MXD\N_BranchSed\RI_REV0\Figure 3C_North Station Site OU Parcels Features.mxd

APPROXIMATE BOUNDARY OF OPERABLE UNIT 1 (UPLAND OU)
APPROXIMATE BOUNDARY OF OPERABLE UNIT 2 (ADJACENT RIVER AREA)
CITY OF CHICAGO PARCEL

REMEDIAL INVESTIGATION REPORT
NORTH BRANCH SEDIMENT INVESTIGATION
CHICAGO, ILLINOIS

NORTH STATION SITE [OU]
PARCEL BOUNDARIES AND SITE FEATURES

SOURCE: PROPERTY LINE INFORMATION OBTAINED FROM COOK COUNTY, ILLINOIS 1:1200-SCALE PARCEL DIGITAL DATA SET, VERSION 1.0, JUNE 2012. OPERABLE UNIT BOUNDARY PROVIDED BY BURNS & MCDONNEL, PROJECT NUMBER 51893, DATED SEPTEMBER 21,2009

O'BRIEN & GERE ENGINEERS, INC.

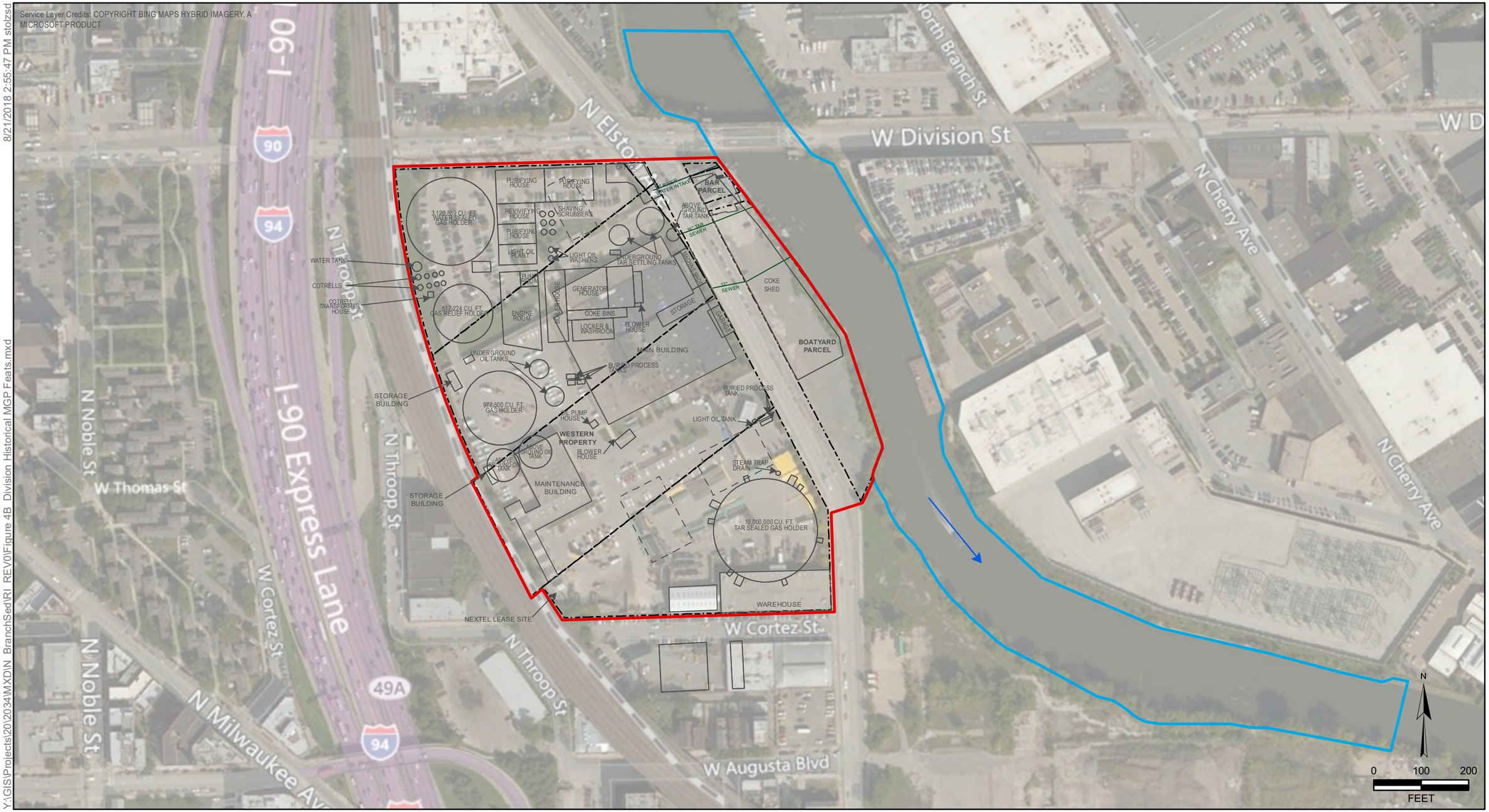
HISTORIC SITE FEATURES
APPROXIMATE BOUNDARY OF OPERABLE UNIT (OU1)
OPERABLE UNIT ADJACENT RIVER AREA
PROPERTY BOUNDARY

NOTE:
1. FORMER FACILITY BOUNDARIES AND HISTORICAL STRUCTURE LOCATIONS ARE APPROXIMATE AND BASED ON HISTORICAL DIAGRAMS.
2. PROCESS BUILDING CONTAINED GENERATORS, CARBURETORS, SUPERHEATERS, SCRUBBERS, CONDENSERS, HYDROMETERS, BOILERS AND ENGINES.
SOURCE NOTE: DRAWING PROVIDED BY BURNS AND MCDONNELL PROJECT NUMBER 51893, DATED SEPTEMBER 21, 2009.

REMEDIAL INVESTIGATION REPORT
NORTH BRANCH SEDIMENT INVESTIGATION
CHICAGO, ILLINOIS

WILLOW STREET SITE [OU] HISTORICAL MGP SITE FEATURES

O'BRIEN & GERE ENGINEERS, INC.



HISTORIC SITE FEATURES
APPROXIMATE BOUNDARY OF OPERABLE UNIT 1 (UPLAND OU)
APPROXIMATE BOUNDARY OF OPERABLE UNIT 2 (ADJACENT RIVER AREA)
PROPERTY BOUNDARY

REMEDIAL INVESTIGATION REPORT
NORTH BRANCH SEDIMENT INVESTIGATION
CHICAGO, ILLINOIS

DIVISION STREET SITE [OU] HISTORICAL MGP SITE FEATURES

O'BRIEN & GERE ENGINEERS, INC.

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Y:\GIS\Projects\20\20344\MXD\N_BranchSed\RI_REV0\Figure 4C_North Station Historical MGP Feats.mxd

HISTORIC SITE FEATURES

APPROXIMATE BOUNDARY OF OPERABLE UNIT 1 (UPLAND OU)

APPROXIMATE BOUNDARY OF OPERABLE UNIT 2 (ADJACENT RIVER AREA)

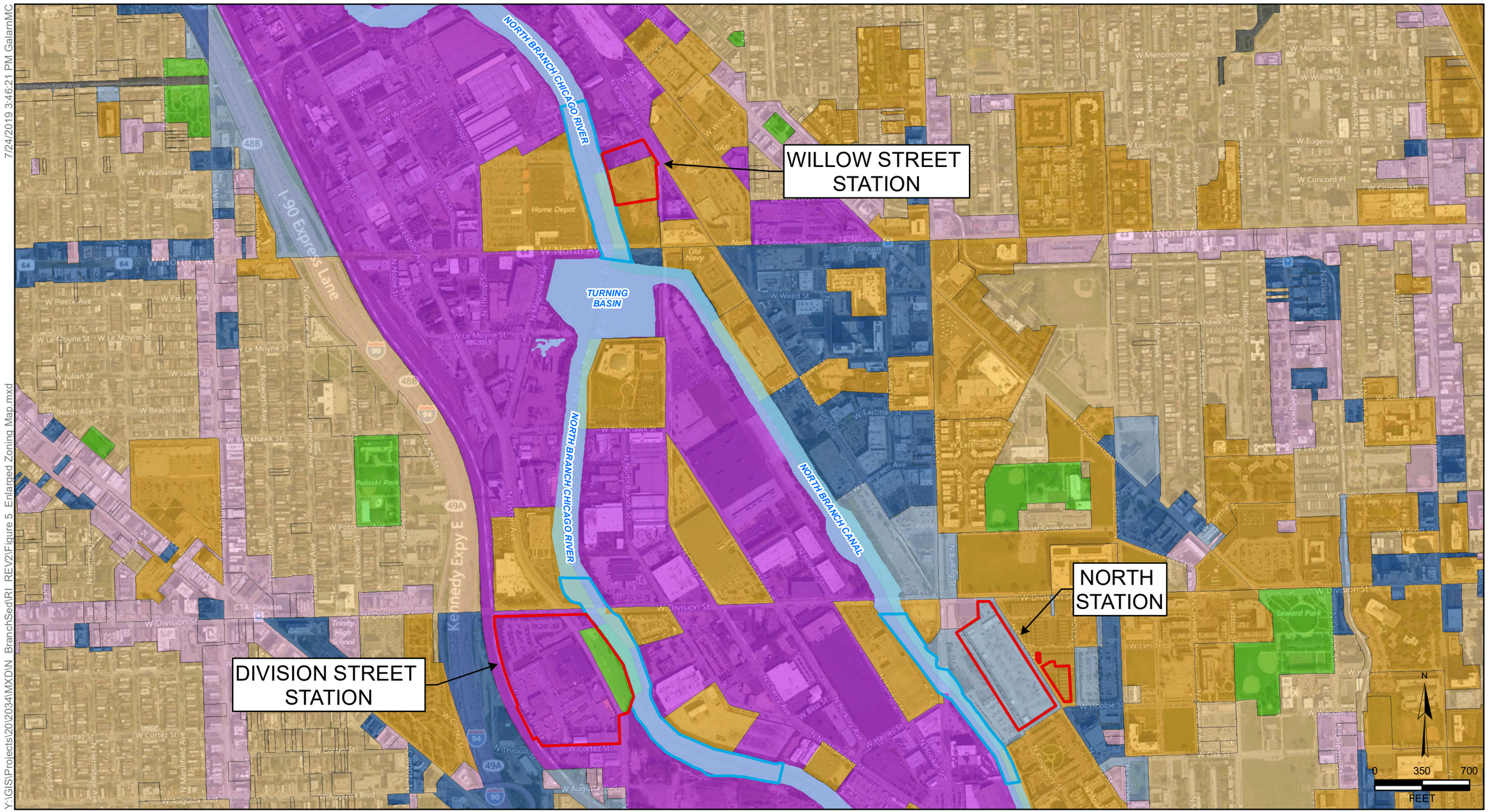
PROPERTY BOUNDARY

SOURCE: PROPERTY LINE INFORMATION OBTAINED FROM COOK COUNTY, ILLINOIS 1:1200-SCALE PARCEL DIGITAL DATA SET, VERSION 1.0, JUNE 2012. OPERABLE UNIT BOUNDARY PROVIDED BY BURNS & MCDONNEL, PROJECT NUMBER 51893, DATED SEPTEMBER 21,2009

REMEDIAL INVESTIGATION REPORT
NORTH BRANCH SEDIMENT INVESTIGATION
CHICAGO, ILLINOIS

NORTH STATION SITE [OU] HISTORICAL MGP SITE FEATURES

O'BRIEN & GERE ENGINEERS, INC.



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Y:\GIS\Projects\2012034\MXD\N_BranchSed\RI_REV2\Figure 5_Enlarged Zoning Map.mxd

WATER
BUSINESS
COMMERCIAL
MANUFACTURING
RESIDENTIAL
PLANNED DEVELOPMENT
PLANNED MANUFACTURING
TRANSPORTATION
PARKS AND OPEN SPACE
APPROXIMATE BOUNDARY OF OPERABLE UNIT 1 (UPLAND OU)
APPROXIMATE BOUNDARY OF OPERABLE UNIT 2 (ADJACENT RIVER AREA)

SOURCE: ZONING INFORMATION OBTAINED FROM COOK COUNTY, ILLINOIS, DOWNLOADED JULY 2018
https://data.cityofchicago.org/Community-Economic-Development/Boundaries-Zoning-Districts-current-/7cve-jgbp
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REMEDIAL INVESTIGATION REPORT
NORTH BRANCH SEDIMENT INVESTIGATION
CHICAGO, ILLINOIS

NORTH BRANCH SITES ZONING MAP

O'BRIEN & GERE ENGINEERS, INC.

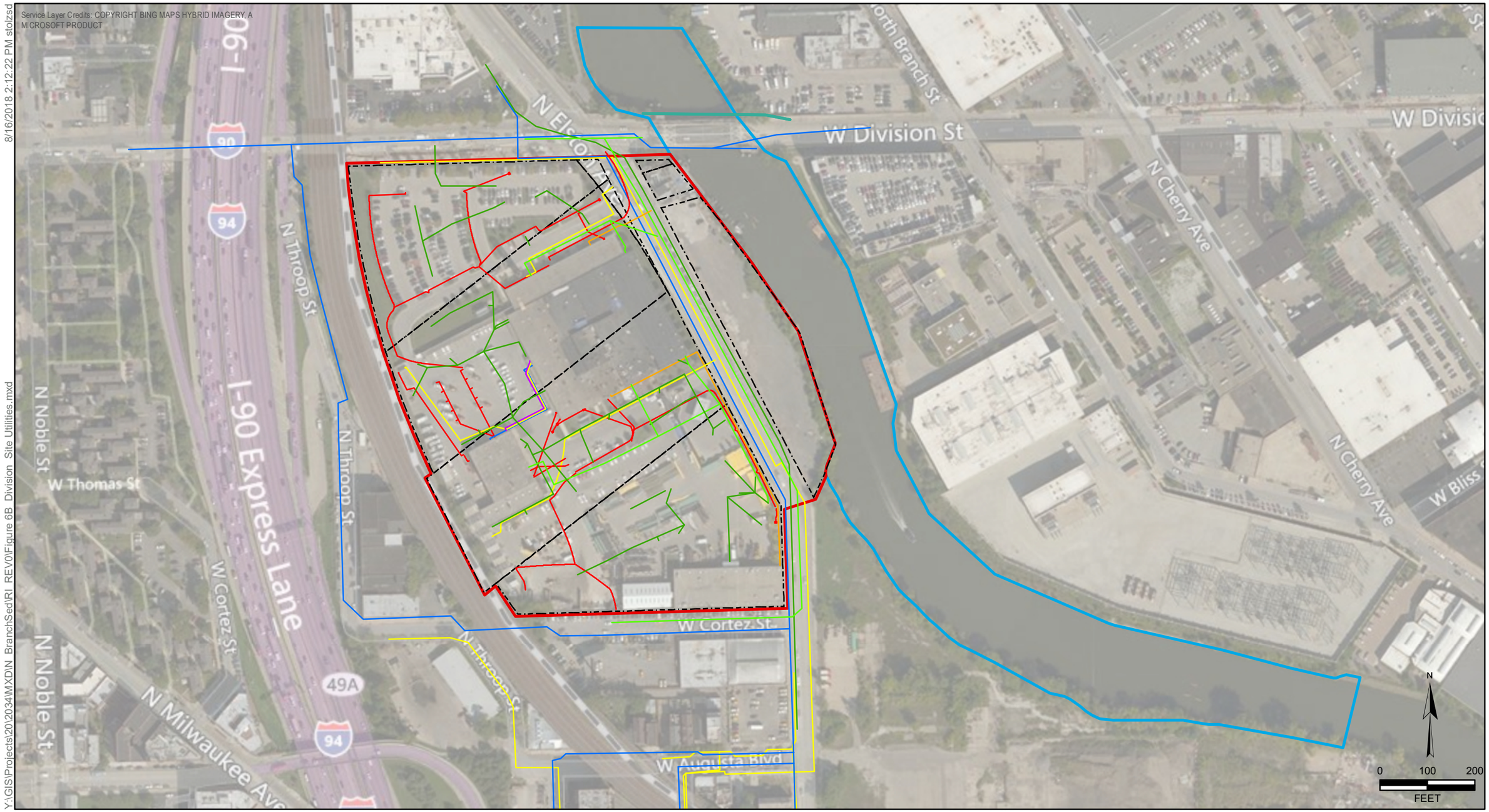
- CABLE UTILIITY
- ELECTRIC UTILIITY
- GAS UTILIITY
- SEWER UTILIITY
- WATER UTILITY
- PGL TUNNEL
- MWRD DEEP TUNNEL
- PROPERTY BOUNDARY
- HISTORIC SITE FEATURE
- APPROXIMATE BOUNDARY OF OPERABLE UNIT 1 (UPLAND OU)
- APPROXIMATE BOUNDARY OF OPERABLE UNIT 2 (ADJACENT RIVER AREA)

INCOMPLETE UTILITY INFORMATION. NOT TO BE USED FOR CONSTRUCTION.
SOURCE: UTILITY DATA DEVELOPED FROM RSB SAMP LOC-PACK NGO.DWG, PROVIDED BY BURNS & MCDONNELL ON MAY 29, 2009

REMEDIAL INVESTIGATION REPORT
NORTH BRANCH SEDIMENT INVESTIGATION
CHICAGO, ILLINOIS

WILLOW STREET SITE UTILITIES

O'BRIEN & GERE ENGINEERS, INC.



- ELECTRIC
- GAS
- SANITARY
- STEAM
- STORM
- TELECOMM
- WATER
- COMED WEST TUNNEL
- PROPERTY BOUNDARY
- APPROXIMATE BOUNDARY OF OPERABLE UNIT 1 (UPLAND OU)
- APPROXIMATE BOUNDARY OF OPERABLE UNIT 2 (ADJACENT RIVER AREA)

INCOMPLETE UTILITY INFORMATION. NOT TO BE USED FOR CONSTRUCTION.

REMEDIAL INVESTIGATION REPORT
NORTH BRANCH SEDIMENT INVESTIGATION
CHICAGO, ILLINOIS

DIVISION STREET SITE UTILITIES

O'BRIEN & GERE ENGINEERS, INC.

Y:\GIS\Projects\20\20341MXD\N_BranchSed\RI_REV0\Figure 6C_North Station Site Utilities.mxd 8/16/2018 2:13:16 PM stolzsd

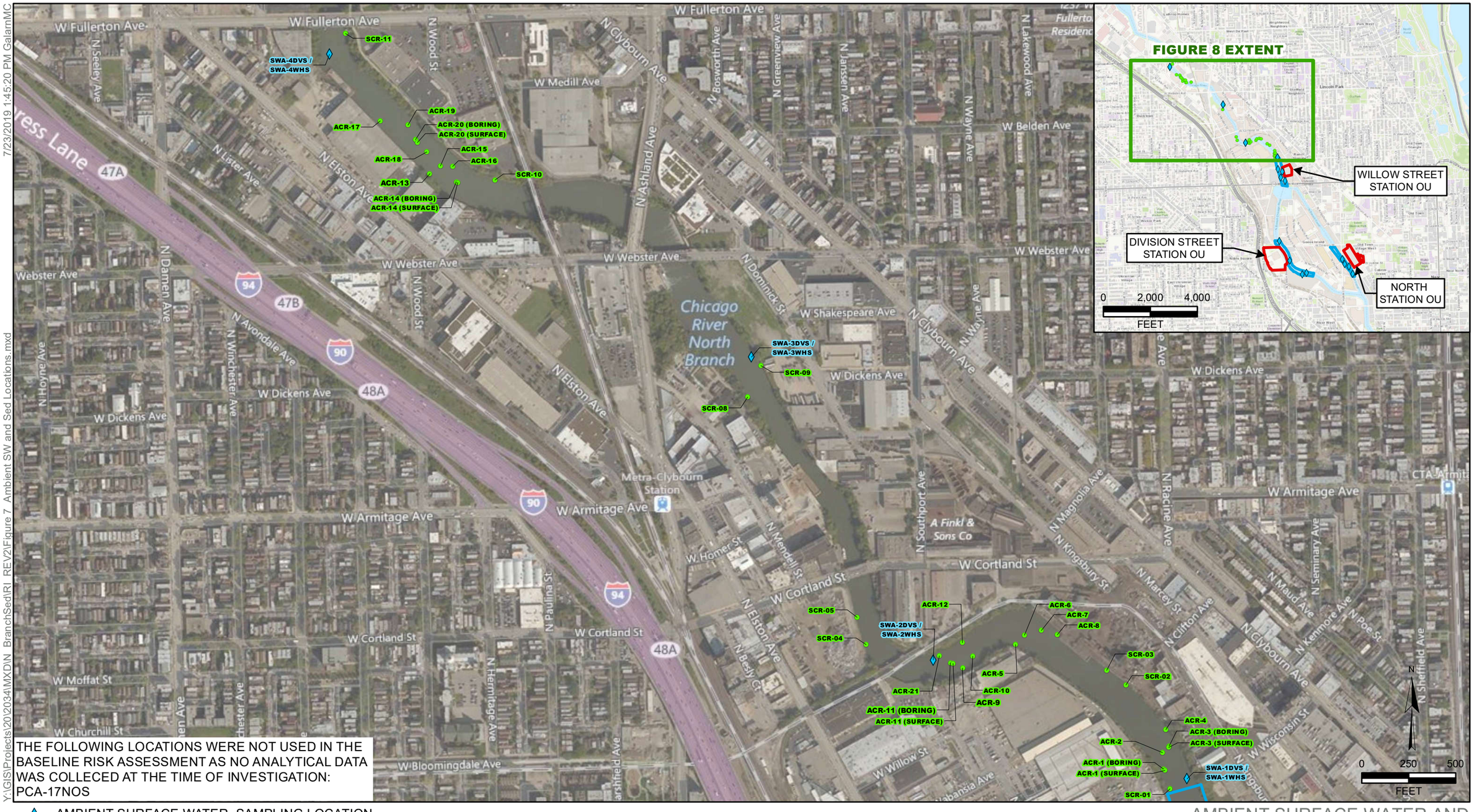
- ELECTRIC LINE
- GAS LINE
- PHONE LINE
- SEWER
- WATER MAIN
- CABLE CROSSING
- MWRD DEEP TUNNEL
- COMED SUBSTATION STRUCTURE
- COMED TUNNEL STRUCTURE
- HISTORICAL SITE FEATURES
- PROPERTY BOUNDARY
- APPROXIMATE BOUNDARY OF OPERABLE UNIT 1 (UPLAND OU)
- APPROXIMATE BOUNDARY OF OPERABLE UNIT 2 (ADJACENT RIVER AREA)

INCOMPLETE UTILITY INFORMATION. NOT TO BE USED FOR CONSTRUCTION.

REMEDIAL INVESTIGATION REPORT
NORTH BRANCH SEDIMENT INVESTIGATION
CHICAGO, ILLINOIS

NORTH STATION SITE UTILITIES

O'BRIEN & GERE ENGINEERS, INC.



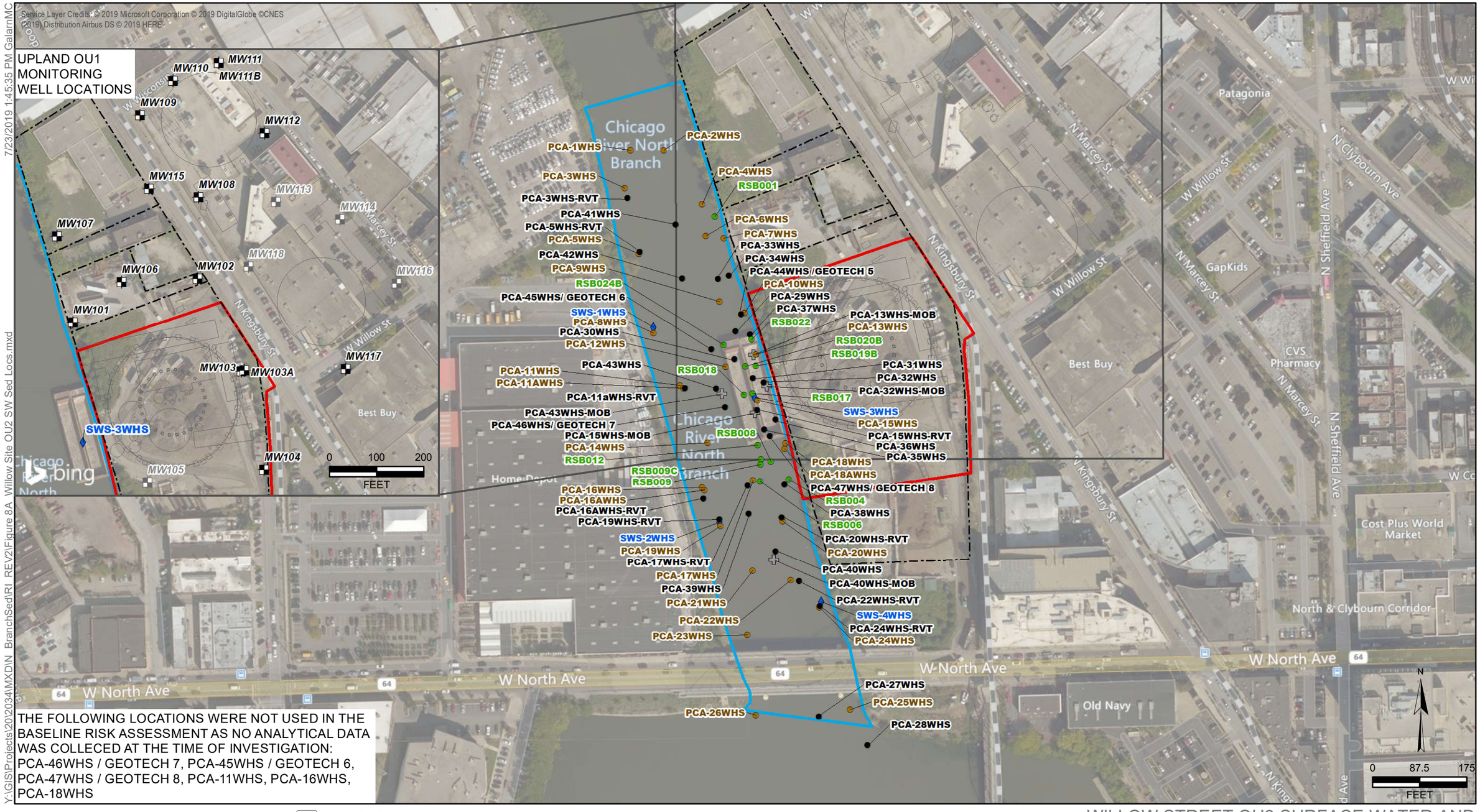
THE FOLLOWING LOCATIONS WERE NOT USED IN THE BASELINE RISK ASSESSMENT AS NO ANALYTICAL DATA WAS COLLECED AT THE TIME OF INVESTIGATION:
PCA-17NOS

- AMBIENT SURFACE WATER SAMPLING LOCATION
- AMBIENT SEDIMENT SAMPLING LOCATION
- APPROXIMATE BOUNDARY OF OPERABLE UNIT 1 (UPLAND OU)
- APPROXIMATE BOUNDARY OF OPERABLE UNIT 2 (ADJACENT RIVER AREA)

REMEDIAL INVESTIGATION REPORT
NORTH BRANCH SEDIMENT INVESTIGATION
CHICAGO, ILLINOIS

AMBIENT SURFACE WATER AND SEDIMENT SAMPLING LOCATIONS

O'BRIEN & GERE ENGINEERS, INC.



THE FOLLOWING LOCATIONS WERE NOT USED IN THE BASELINE RISK ASSESSMENT AS NO ANALYTICAL DATA WAS COLLECED AT THE TIME OF INVESTIGATION: PCA-46WHS / GEOTECH 7, PCA-45WHS / GEOTECH 6, PCA-47WHS / GEOTECH 8, PCA-11WHS, PCA-16WHS, PCA-18WHS

- SEDIMENT SAMPLING LOCATION, 2013
- SEDIMENT SAMPLING LOCATION, 2012
- MOBILITY STUDY LOCATION, 2013
- SURFACE WATER SAMPLING LOCATION, 2012
- SEDIMENT SAMPLING LOCATION, 2006
- MONITORING WELL LOCATION
- ABANDONED (2014) MONITORING WELL LOCATION
- HISTORICAL SITE FEATURES
- PROPERTY BOUNDARY
- APPROXIMATE BOUNDARY OF OPERABLE UNIT 1 (UPLAND OU)
- APPROXIMATE BOUNDARY OF OPERABLE UNIT 2 (ADJACENT RIVER AREA)

REMEDIAL INVESTIGATION REPORT
NORTH BRANCH SEDIMENT INVESTIGATION
CHICAGO, ILLINOIS

WILLOW STREET OU2 SURFACE WATER AND SEDIMENT SAMPLING LOCATIONS

O'BRIEN & GERE ENGINEERS, INC.

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Y:\GIS\Projects\20\2034\MXD\N_BranchSed\RI_REV2\Figure 8A_Willow Site OU2 SW Sed Locs.mxd

UPLAND OU1 MONITORING WELL LOCATIONS

MW115
PZ115
MW112
MW101
PZ118
MW118
MW110
PZ116
MW116
MW109
MW111
MW102
MW103
MW105
PZ117
MW104
MW117
MW114
SWS-2DIV
MW108
MW113
MW107
MW106

0 125 250
FEET

STA-74DSS
STA-84DSS
STA-73DSS
STA-21DSS-RVT
STA-72DSS
STA-21DSS
SWS-1DIV
STA-60DSS
STA-59DSS
STA-61DSS
STA-22DSS
STA-22DSS-MOB
STA-1DSS-RVT
STA-22DSS-RVT
STA-1DSS
STA-62DSS
STA-2DSS
STA-3DSS
STA-45DSS-MOB
STA-45DSS
STA-24DSS
STA-23DSS
STA-46DSS
STA-4DSS
STA-25DSS
STA-23DSS-RVT
STA-25ADSS
STA-4DSS-RVT
STA-26DSS
STA-47DSS /GEOTECH-1
STA-75DSS
STA-48DSS
STA-26ADSS
STA-5DSS
STA-68DSS /GEOTECH 3
STA-49DSS
STA-27DSS
STA-6DSS
STA-76DSS
STA-50DSS
STA-28DSS
STA-7DSS
STA-83DSS /GEOTECH 9
STA-51DSS
STA-52DSS
STA-8DSS
STA-77DSS
STA-8DSS-MOB
STA-54DSS
STA-9DSS
STA-70DSS /GEOTECH 2
STA-29DSS
SWS-2DIV
STA-53DSS
STA-30DSS
STA-55DSS
STA-56DSS
STA-10DSS
STA-11DSS
STA-57DSS
STA-31DSS
STA-58DSS
STA-32DSS
STA-12DSS
STA-64DSS
STA-33DSS
STA-71DSS /GEOTECH 4
STA-71DSS-MOB
STA-63DSS
STA-13DSS
STA-78DSS
STA-14BDSS
STA-14ADSS
STA-14DSS
STA-15ADSS
STA-15DSS
STA-16DSS
STA-80DSS
STA-17DSS
STA-18DSS
STA-81DSS
SWS-4DIV
STA-19DSS-MOB
STA-19DSS-RVT
STA-19DSS
STA-34DSS
STA-65DSS
STA-35DSS
STA-79DSS
STA-36DSS
STA-66DSS
STA-37DSS
STA-38DSS
STA-38DSS-RVT
STA-67DSS
STA-39DSS
SWS-3DIV
STA-40DSS
STA-42DSS
STA-82DSS
STA-41DSS
STA-44DSS
STA-43DSS
STA-20DSS
STA-69DSS

N

0 112.5 225
FEET

THE FOLLOWING LOCATIONS WERE NOT USED IN THE BASELINE RISK ASSESSMENT AS NO ANALYTICAL DATA WAS COLLECED AT THE TIME OF INVESTIGATION:
STA-14DSS, STA-15DSS, STA-68DSS / GEOTECH 3, STA-70DSS / GEOTECH 2, STA-83DSS / GEOTECH 9

- SEDIMENT SAMPLING LOCATION, 2013
- SEDIMENT SAMPLING LOCATION, 2012
- MOBILITY STUDY LOCATION, 2013
- SURFACE WATER SAMPLING LOCATION, 2012
- MONITORING WELL LOCATION
- HISTORICAL SITE FEATURES
- APPROXIMATE BOUNDARY OF OPERABLE UNIT 1 (UPLAND OU)
- APPROXIMATE BOUNDARY OF OPERABLE UNIT 2 (ADJACENT RIVER AREA)
- PROPERTY BOUNDARY

REMEDIAL INVESTIGATION REPORT
NORTH BRANCH SEDIMENT INVESTIGATION
CHICAGO, ILLINOIS

DIVISION STREET OU2 SURFACE WATER AND SEDIMENT SAMPLING LOCATIONS

O'BRIEN & GERE ENGINEERS, INC.

THE FOLLOWING LOCATIONS WERE NOT USED IN THE BASELINE RISK ASSESSMENT AS NO ANALYTICAL DATA WAS COLLECED AT THE TIME OF INVESTIGATION:
PCA-17NOS

PCA-30NOS
PCA-29NOS
PCA-28NOS
PCA-26NOS
PCA-27NOS
PCA-25NOS
PCA-24NOS
PCA-23NOS
PCA-22NOS
PCA-21NOS
PCA-19NOS
SWS-20NOS
PCA-20NOS
PCA-18NOS
PCA-15NOS
PCA-16NOS
PCA-17NOS
PCA-17ANOS
PCA-14NOS
PCA-33NOS
PCA-32NOS-MOB
PCA-32NOS
PCA-13NOS
SWS-13NOS
PCA-12NOS-MOB
PCA-12NOS
PCA-10NOS
SWS-10NOS
PCA-11NOS
PCA-9NOS
PCA-8NOS
PCA-31NOS
PCA-7NOS
PCA-6ANOS
PCA-6NOS
PCA-5NOS
SWS-4NOS
PCA-4NOS
PCA-3NOS
PCA-2NOS
PCA-1NOS

UPLAND OU1 MONITORING WELL LOCATIONS

NOS-MWW102
NOS-MWP101
NOS-MWW101
NOS-SU1
MW-5
SP-11
SP-2
SP-12
NOS-MWP114
NOS-MWW114
NOS-MWP103
NOS-MWW103
SP-14
MW-4
SWS-20NOS
MW-2
NOS-MWW104
MW-3
NOS-MWP111
NOS-MWW111
NOS-MWW116
MW-1
SP-5
SWS-13NOS
NOS-MWP115
NOS-MWW115
SWS-10NOS
NOS-MWP109
NOS-MWP108
NOS-MWP105
NOS-MWW105
NOS-MWP106

N
0 125 250
FEET

N
0 75 150
FEET

- SEDIMENT SAMPLING LOCATION, 2013
- MOBILITY STUDY LOCATION, 2013
- SURFACE WATER SAMPLING LOCATION, 2012
- MONITORING WELL LOCATION
- HISTORICAL SITE FEATURES
- APPROXIMATE BOUNDARY OF OPERABLE UNIT 1 (UPLAND OU)
- APPROXIMATE BOUNDARY OF OPERABLE UNIT 2 (ADJACENT RIVER AREA)
- PROPERTY BOUNDARY

REMEDIAL INVESTIGATION REPORT
NORTH BRANCH SEDIMENT INVESTIGATION
CHICAGO, ILLINOIS

NORTH STATION OU2 SURFACE WATER AND SEDIMENT SAMPLING LOCATIONS

O'BRIEN & GERE ENGINEERS, INC.

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Y:\GIS\Projects\20\20341\MXD\N_BranchSed\RI_REV1\Figure 8C_North Station OU2 SW Sed Locs.mxd

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Y:\GIS\Projects\20\20341\MXD\N_BranchSed\RI_REV2\Figure 9A_Willow Bathy Survey Contours.mxd

BATHYMETRIC SURFACE MAJOR CONTOURS, NAVD88 FT. (BY AMERICAN SURVEY, DEC. 2011)

BATHYMETRIC SURFACE MINOR CONTOURS, NAVD88 FT. (BY AMERICAN SURVEY, DEC. 2011)

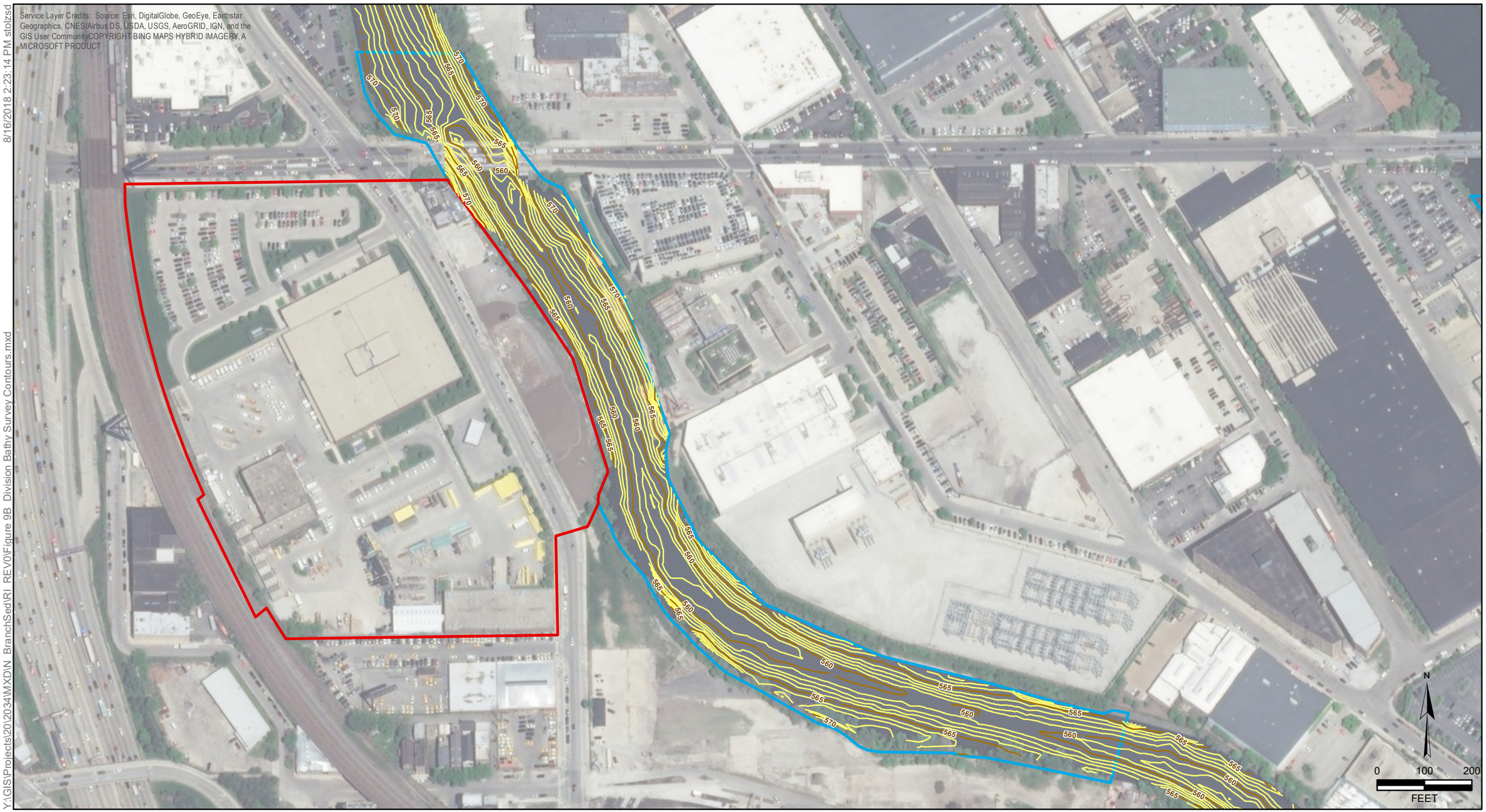
APPROXIMATE BOUNDARY OF OPERABLE UNIT 1 (UPLAND OU)

APPROXIMATE BOUNDARY OF OPERABLE UNIT 2 (ADJACENT RIVER AREA)

REMEDIAL INVESTIGATION REPORT
NORTH BRANCH SEDIMENT INVESTIGATION
CHICAGO, ILLINOIS

WILLOW STREET BATHYMETRIC SURVEY CONTOURS

O'BRIEN & GERE ENGINEERS, INC.



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Y:\GIS\Projects\20\20341MXD\N_BranchSed\RI_REV0\Figure 9B_Division Bathy Survey Contours.mxd

BATHYMETRIC SURFACE MAJOR CONTOURS, NAVD88 FT. (BY AMERICAN SURVEY, DEC. 2011)

BATHYMETRIC SURFACE MINOR CONTOURS, NAVD88 FT. (BY AMERICAN SURVEY, DEC. 2011)

APPROXIMATE BOUNDARY OF OPERABLE UNIT 1 (UPLAND OU)

APPROXIMATE BOUNDARY OF OPERABLE UNIT 2 (ADJACENT RIVER AREA)

REMEDIAL INVESTIGATION REPORT
NORTH BRANCH SEDIMENT INVESTIGATION
CHICAGO, ILLINOIS

DIVISION STREET BATHYMETRIC SURVEY CONTOURS

O'BRIEN & GERE ENGINEERS, INC.

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Y:\GIS\Projects\20\2034\MXD\N_BranchSed\RI_REV0\Figure 9C_North Station Bathy Survey Contours.mxd

BATHYMETRIC SURFACE MAJOR CONTOURS, NAVD88 FT. (BY AMERICAN SURVEY, MAR. 2013)

BATHYMETRIC SURFACE MINOR CONTOURS, NAVD88 FT. (BY AMERICAN SURVEY, MAR. 2013)

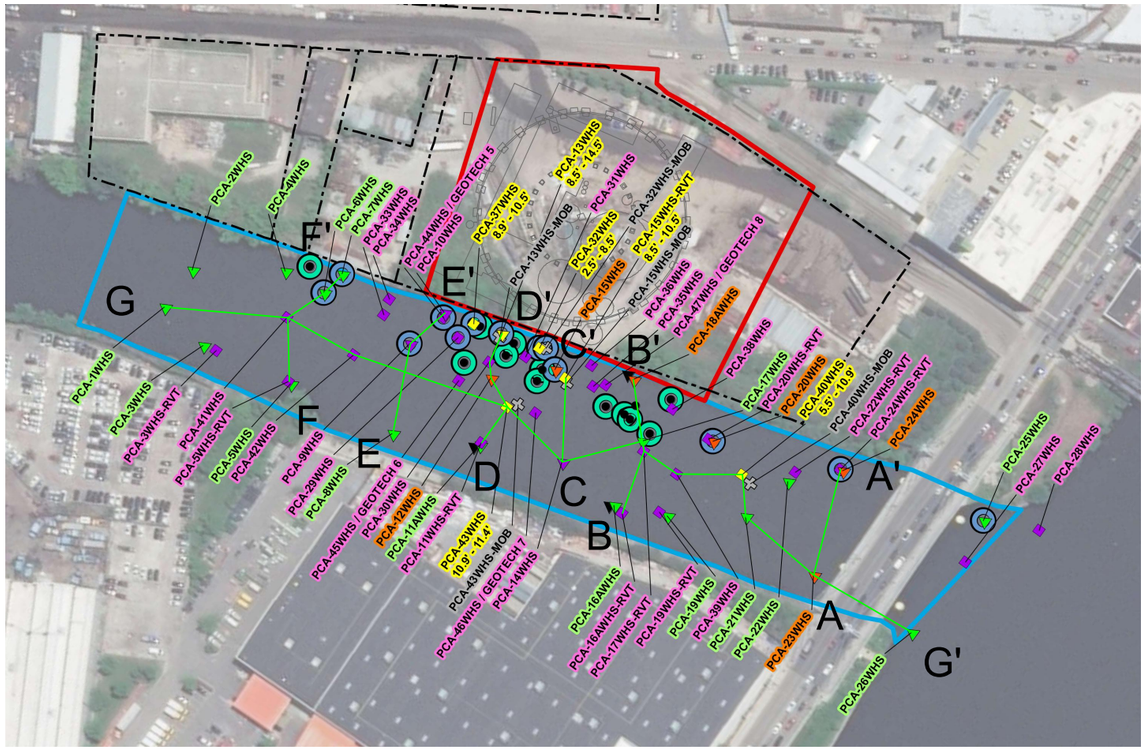
APPROXIMATE BOUNDARY OF OPERABLE UNIT 1 (UPLAND OU)

APPROXIMATE BOUNDARY OF OPERABLE UNIT 2 (ADJACENT RIVER AREA)

REMEDIAL INVESTIGATION REPORT
NORTH BRANCH SEDIMENT INVESTIGATION
CHICAGO, ILLINOIS

NORTH STATION BATHYMETRIC SURVEY CONTOURS

O'BRIEN & GERE ENGINEERS, INC.



PLAN VIEW

0 100 200 400

SCALE IN FEET

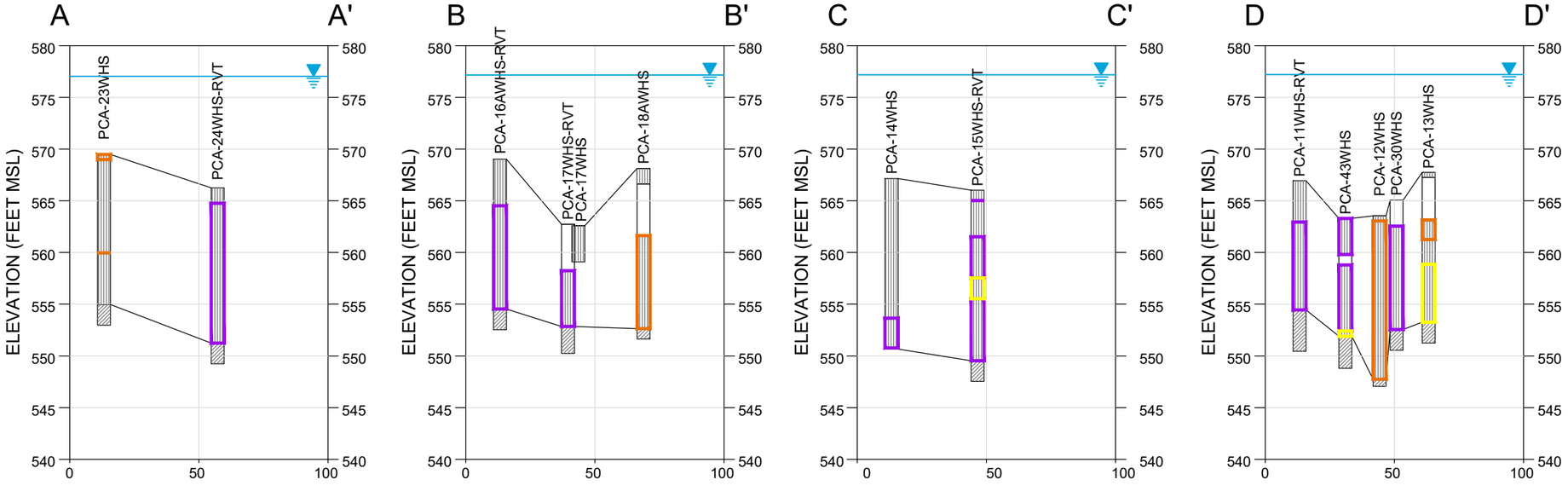
N

CROSS-SECTIONS

VERTICAL SCALE IN FEET 12.5

HORIZONTAL SCALE IN FEET 50

VERTICAL EXAGGERATION = 4



STEP I (2012) LOCATIONS

- SEDIMENT BORING LOCATION WITH NO RECOVERY
- PCA-2WHS — SEDIMENT BORING LOCATION WITH NO SIGNIFICANT OBSERVATIONS OF MGP EFFECTS
- PCA-15WHS — SEDIMENT BORING LOCATION OBSERVATIONS OF SHEEN ON SEDIMENT OR WATER
- PCA-10WHS — SEDIMENT BORING LOCATION; PID RESPONSE GREATER THAN 2 PARTS PER MILLION (PPM), AND/OR STAINING, AND/OR ODOR
- PCA-13WHS — SEDIMENT BORING LOCATION OBSERVATIONS OF NAPL OR OIL-COATED / OIL-WETTED SEDIMENT

STEP II (2013) LOCATIONS

- SDS-MOB — MOBILITY STUDY LOCATION
- STA-1DSS — SEDIMENT BORING LOCATION WITH NO SIGNIFICANT OBSERVATIONS OF MGP IMPACTS
- STA-1DSS — SEDIMENT BORING LOCATION OBSERVATIONS OF SHEEN ON SEDIMENT OR WATER
- PCA-33WHS — SEDIMENT BORING LOCATION; PID RESPONSE GREATER THAN 2 PPM, AND/OR STAINING, AND/OR ODOR
- PCA-43WHS — SEDIMENT BORING LOCATION OBSERVATIONS OF NAPL OR OIL-COATED / OIL-WETTED SEDIMENT
- 8.5' - 14.5' — DEPTH OF NAPL

HISTORIC (2006) LOCATIONS

- RSB024 — SEDIMENT BORING LOCATION WITH NO SIGNIFICANT OBSERVATIONS OF MGP IMPACTS
- RSB022 — SEDIMENT BORING LOCATION OBSERVATIONS OF SHEEN ON SEDIMENT OR WATER
- RSB011 — SEDIMENT BORING LOCATION; PID RESPONSE GREATER THAN 2 PPM, AND/OR STAINING, AND/OR ODOR
- RSB019C — SEDIMENT BORING LOCATION OBSERVATIONS OF NAPL OR OIL-COATED / OIL-WETTED SEDIMENT
- LOCATION WITH TOTAL PAH EXCEEDANCE OF UPPER TOLERANCE LIMIT (UTL) AT SUBSURFACE (> 1.5') - 2006 HISTORIC DATA (FORENSIC EVALUATION NOT COMPLETED)
- STA-1DSS — LOCATION WITH TOTAL PAH EXCEEDANCE OF UTL AT SUBSURFACE (> 1.5') - NON-AMBIENT DERIVED*
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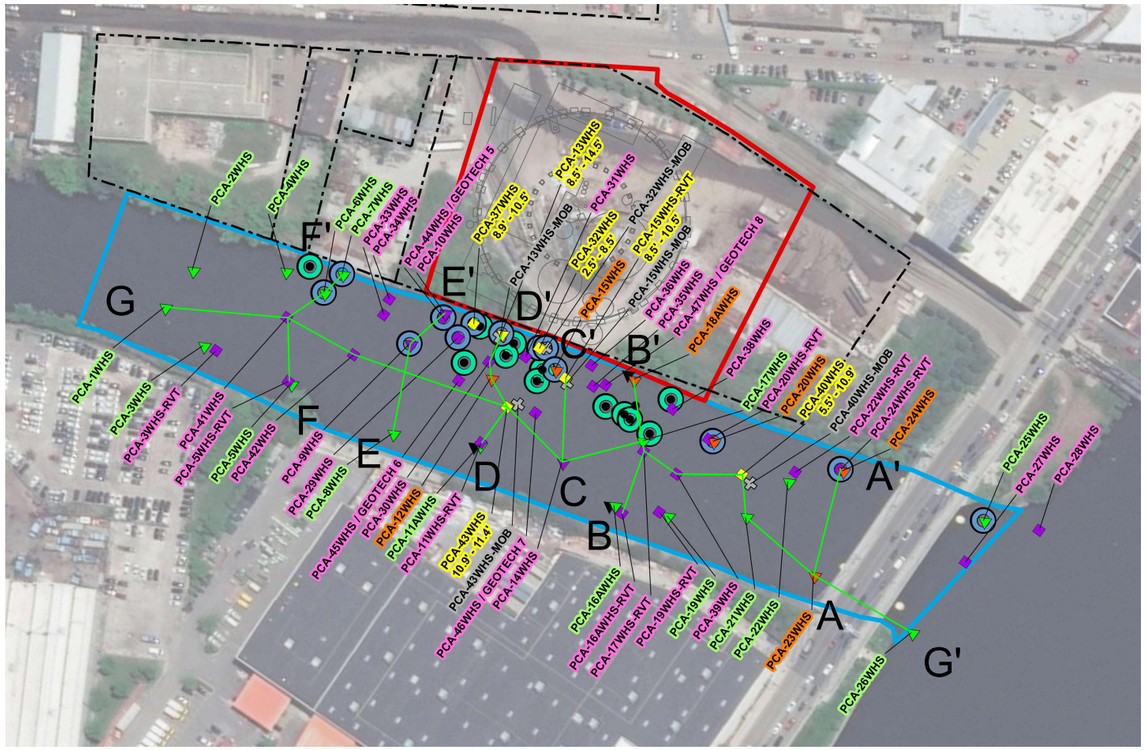
- ADJACENT RIVER AREA
- PARCEL BOUNDARY
- FORMER MGP STRUCTURE
- A' — A CROSS SECTION LINE
- CLAY
- GRAVEL
- NO RECOVERY
- ORGANIC SILT
- SILT
- SAND
- APPROXIMATE WATER SURFACE ELEVATION

REMEDIAL INVESTIGATION REPORT
NORTH BRANCH SEDIMENT INVESTIGATION
CHICAGO, IL

WILLOW STREET
SEDIMENT CROSS SECTIONS
A-A', B-B', C-C', D-D'

JULY 2019

O'BRIEN & GERE ENGINEERS, INC.

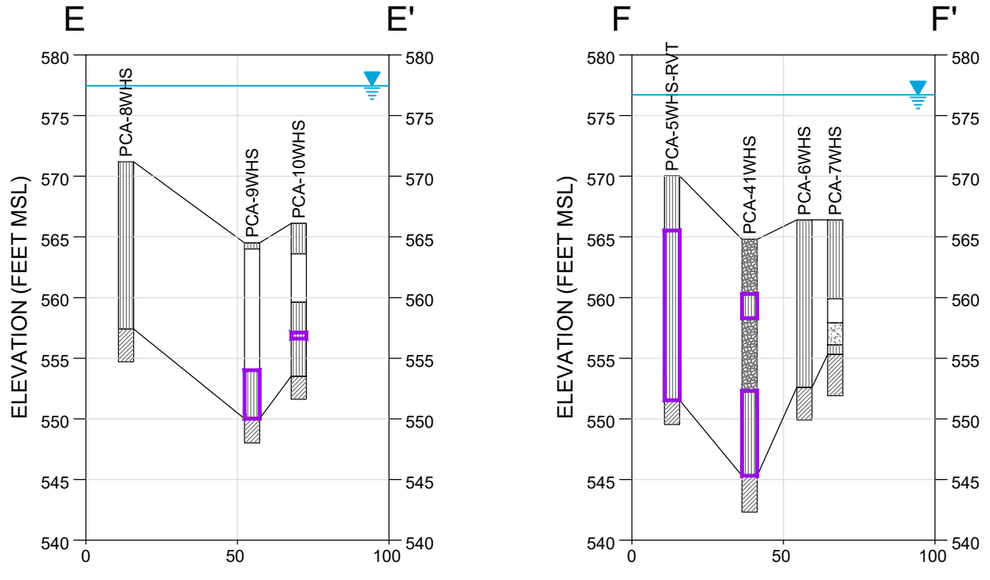


PLAN VIEW

0 100 200 400

SCALE IN FEET

N



CROSS-SECTIONS

VERTICAL SCALE IN FEET: 12.5

HORIZONTAL SCALE IN FEET: 50

VERTICAL EXAGGERATION = 4

STEP I (2012) LOCATIONS

- SEDIMENT BORING LOCATION WITH NO RECOVERY
- PCA-2WHS — SEDIMENT BORING LOCATION WITH NO SIGNIFICANT OBSERVATIONS OF MGP EFFECTS
- PCA-15WHS — SEDIMENT BORING LOCATION OBSERVATIONS OF SHEEN ON SEDIMENT OR WATER
- PCA-10WHS — SEDIMENT BORING LOCATION; PID RESPONSE GREATER THAN 2 PARTS PER MILLION (PPM), AND/OR STAINING, AND/OR ODOR
- PCA-13WHS — SEDIMENT BORING LOCATION OBSERVATIONS OF NAPL OR OIL-COATED / OIL-WETTED SEDIMENT

STEP II (2013) LOCATIONS

- SDS-MOB — MOBILITY STUDY LOCATION
- STA-1DSS — SEDIMENT BORING LOCATION WITH NO SIGNIFICANT OBSERVATIONS OF MGP IMPACTS
- STA-1DSS — SEDIMENT BORING LOCATION OBSERVATIONS OF SHEEN ON SEDIMENT OR WATER
- PCA-33WHS — SEDIMENT BORING LOCATION; PID RESPONSE GREATER THAN 2 PPM, AND/OR STAINING, AND/OR ODOR
- PCA-43WHS — SEDIMENT BORING LOCATION OBSERVATIONS OF NAPL OR OIL-COATED / OIL-WETTED SEDIMENT
- 8.5' - 14.5' — DEPTH OF NAPL

HISTORIC (2006) LOCATIONS

- RSB024 — SEDIMENT BORING LOCATION WITH NO SIGNIFICANT OBSERVATIONS OF MGP IMPACTS
- RSB022 — SEDIMENT BORING LOCATION OBSERVATIONS OF SHEEN ON SEDIMENT OR WATER
- RSB011 — SEDIMENT BORING LOCATION; PID RESPONSE GREATER THAN 2 PPM, AND/OR STAINING, AND/OR ODOR
- RSB019C — SEDIMENT BORING LOCATION OBSERVATIONS OF NAPL OR OIL-COATED / OIL-WETTED SEDIMENT
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NORTH BRANCH SEDIMENT INVESTIGATION
CHICAGO, IL

WILLOW STREET
SEDIMENT CROSS SECTIONS
E-E', F-F'

JULY 2019

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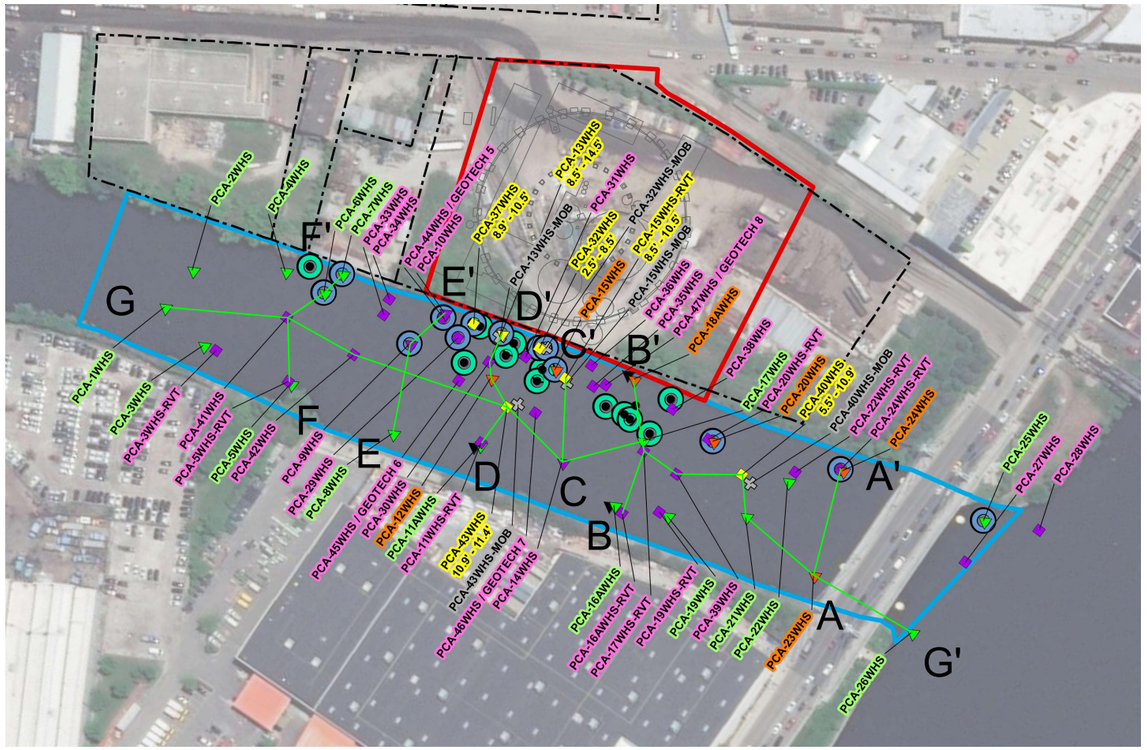
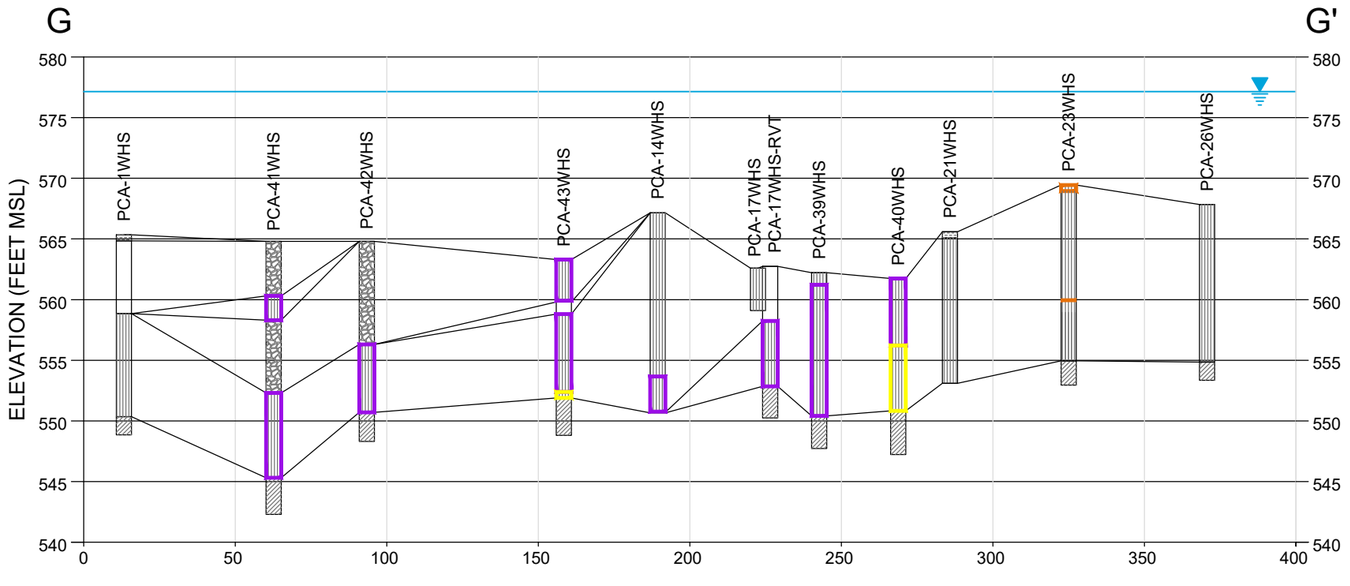


PLAN VIEW

0 100 200 400

SCALE IN FEET

N



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REMEDIAL INVESTIGATION REPORT
NORTH BRANCH SEDIMENT INVESTIGATION
CHICAGO, IL

WILLOW STREET
SEDIMENT CROSS SECTION
G-G'

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